PROCEEDINGS

EPA National Forum on Vapor Intrusion
January 12-13, 2009
Loews Hotel, Philadelphia, PA

(Image courtesy of Interstate Technical and Regulatory Council)

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INTRODUCTION

The environmental issue of vapor intrusion, which can result from soil and groundwater contamination in areas below a building, has become a priority topic for many areas of the country. These are typically areas where volatile organic compounds are present in the subsurface. Just when the contamination at many sites was thought to be under control, it's become obvious that this new exposure pathway is part of the environmental risk at many Superfund sites. In March, 2008 in San Diego, a workshop was held that brought together a number of practitioners and community members. People from both groups learned from each other. The regulators and industry representatives taught the community folks and the community folks (those impacted) shared their experiences about vapor intrusion in their homes. Soon after, there was a call for an east coast version of the workshop. It was called the "EPA National Forum on Vapor Intrusion". EPA Superfund and Technology Liaisons Bill Hagel (EPA Region 3) and Michael Gill (EPA Region 9) led this 2-day Forum, which was held in Philadelphia on January 12–13, 2009. The Forum covered dual tracks highlighting community stakeholder and government issues. These following proceedings cover this Philadelphia gathering.

A planning committee consisting of personnel from EPA (Regions 3, 6, 9, EPA Headquarters and the Office of Research and Development) and community stakeholders worked together to develop the agenda. The agenda included a plenary session with four speakers; technical sessions covering vapor intrusion sampling and assessment, risk assessment, and engineering and site development; two breakout sessions (one for community stakeholders and one for government program issues); and a series of vapor intrusion case studies. In the end, almost 400 people attended the Forum. It brought together groups of people (community, regulators, industry) who typically do not get to express their experiences to a mixed audience. All parties learned from one another at this Forum, just as they had in San Diego almost a year earlier. Hopefully, they will be able to either do their work in this field with more understanding or if they live with vapor intrusion, now they can better comprehend the issues surrounding these exposures.

Bill and Mike would like to express their thanks to all who contributed to the success of the Forum, both planning committee members, financial sponsors, and of course, to the speakers. The planning committee included: Sai Appaji, John Boyer, Michele Conlon, Kathy Davies, Douglas Grosse, Jennifer Hubbard, Dawn Ioven, Alana Lee, Jack Kelly, David Polish, Henry Schuver, Lenny Siegel, Peter Strauss, and Michael Taurino. And last, but not least, thanks go out to our support contractor, Nathalie Panayiotakis of CSS, Inc.

Proceedings for the Forum are available at the following website:
http://www.epa.gov/osp/hstl/stlworkshops.htm .

MONDAY, JANUARY 12, 2009

Plenary Session

Opening Remarks

Mr. Bill Hagel, U.S. EPA Region 3, Philadelphia, PA, opened the Forum and recognized the efforts of Mr. Michael Gill, U.S. EPA, Region 9, San Francisco, CA. Mr. Hagel said that the goals of the Forum were to expand on the National Stakeholder Forum held in March 2008; to present and discuss the state of the practice on vapor intrusion (VI); and to bring together a myriad of interests and backgrounds to discuss VI. He then acknowledged the efforts of the planning committee, the supporting offices, and the contract support.

Welcome to Region 3

Jim Burke, Director, Hazardous Site Control Division, EPA Region 3, said that it was heartening to see so many people in attendance. He noted that he had been told this Forum was the largest to date on VI, and that it had excellent State representation. Mr. Burke commented that EPA is known for its ability to seek and utilize partnerships. The Forum attendees included Federal and State regulators, community stakeholders, and other groups, and all are needed to make it a success. Mr. Burke thanked Bill Hagel, Henry Schuver, Len Siegel, and John Boyer, noting that they were all instrumental in developing the Forum. He reiterated that partnerships are one of the trademarks of EPA, and said that the Agency wants all participants to be better informed and one step closer to addressing the problems posed by VI.

EPA Perspective on Vapor Intrusion

Henry Schuver, Chair of the Vapor Intrusion Workgroup, U.S. EPA Office of Solid Waste and Emergency Response (OSWER), Washington, DC, said that EPA's perspective on VI is much larger than that of cleanup only programs. The topic of VI is growing, and the focus is on the pathway, he said. Mr. Schuver defined VI as the intrusion of gases from the subsurface into the indoor air of buildings above. Nearby contamination can be swept inside by active flow, and more distant contamination can be transported by diffusion over time to the zone where it can be swept inside. Contaminated ground water is the most common source of these gases, which escapes from the water into the gaseous phase. Volatile organic compounds partition into the air. Another important concept in VI is attenuation, defined as the ratio of the concentration in indoor air to the concentration at the source zone, or, the fraction of indoor air made up of contaminants. Mr. Schuver noted that the same pathway and similar mechanisms apply to radon, which is the one of the most serious carcinogens the Agency addresses for the general public.

In reviewing the chemical pathway, Mr. Schuver noted the different exposure factors associated with ingestion of water vs. inhalation of air: 20,000 Liters/day of air may be inhaled, vs. 2 Liters/day of water ingested. The dominant features of the complicated VI pathway are uncertainty due to lack of knowledge, and variability that is known but is unpredictable. Mr. Schuver presented some three pages of variables that have been reported by scientific research on radon and other topics and noted that some are still unidentified.

EPA is continuing to work on VI, summarizing guidance and other documents. Mr. Schuver said that EPA is doing all that is possible to improve knowledge, and encouraged attendees to think of the Forum as a major step forward.

Community Stakeholder Perspective on Vapor Intrusion

Lenny Siegel, Executive Director of the Center for Public Environmental Oversight, Mountain View, CA. said that positive stakeholder involvement is crucial. Scientists cannot do anything to mitigate VI unless the public understands them. Regulators and communities need to work closely to improve communication. Communication about VI is complex. Only a few members of the public understand VI, Mr. Siegel said, but sometimes those people understand more than the experts do, due to the length of their involvement (e.g., as related to their own home).

One issue when communicating with community stakeholders is that the public is concerned about their property values. Another is that stakeholders often want sampling because they do not trust the use of models; conversely, others do not want the government in their homes for sampling, or for any reason. Community stakeholders tend to prefer real-time sampling, he said.

Community members tend to want mitigation if their home is located above the plume, even if measurements in that particular home are not above the threshold. It can be difficult for stakeholders to understand why their neighbors get mitigation but they do not. He also said that communities do not believe mitigation to be a long-term solution. They tend to like newer, innovative technologies that would accelerate the removal of contaminants from groundwater. Because it is never possible to remove all the contamination, communities are concerned about long-term issues. For long-term management and monitoring, the regulators must ensure that systems are working for the lifetime of the contamination. It is also important, Mr. Siegel said, that management related to land use and new construction is planned out before cleanup is started. Communities are also concerned about the levels of contamination allowed. For example, there is concern that the PCE standards are much weaker than the TCE standards, especially in New York State. Finally, Mr. Siegel noted, communities are concerned that EPA has not finalized the VI guidance.

Vapor Intrusion Pathway: ITRC and States' Perspectives

John Boyer of the New Jersey Department of Environmental Protection and co-chair of the ITRC VI Team, reviewed State regulatory agencies' impact on VI. ITRC, the Interstate Technology and Regulatory Council, is run by State regulatory agencies, and includes academia, consultants, community stakeholders, and Federal representatives. ITRC works on innovative technologies and other issues.

Putting the issue into historical perspective, Mr. Boyer noted that environmental investigations for VI have only been conducted for about 20 years. VI has a broad impact on State regulatory programs, and therefore State resources, he said. Communities look forward to receiving No Further Action (NFA) status, but with VI, they have no assurance that this status is permanent. States have begun to reexamine closed VI cases.

Because VI is a complex pathway, it poses an interdisciplinary challenge, Mr. Boyer said. He noted numerous differences, e.g., the attenuation factors used vary between U.S. EPA and the states; biodegradation is handled differently among the states (and some do not address it at all); and indoor air screening levels differ dramatically (by orders of magnitude) among the states. Multiple Lines of Evidence (MLE) is a key concept, Mr. Boyer said; that is, one cannot accept a single line of evidence in order to say that there is a problem. He noted that regulators are used to looking at numbers and criteria to determine whether there is a problem, which is a different approach. Because going into people's houses is dramatic, community outreach needs much more interaction, and regulators need to explain what is going on.

ITRC is providing classroom training on VI in April 2009 in Oklahoma City, Mr. Boyer noted. The training is geared to people with limited to no knowledge of VI, and will go through a step-wise process of identifying, measuring, and remediating sites.

Community Case Studies (Lenny Siegel, Moderator)

Vapor Intrusion and Social Science: The Case of TCE Contamination in Endicott, NY

Mr. Peter Little described Endicott, NY, as a "poster child for VI and TCE remediation." Endicott was the location of IBM's first plant, which was sold in 2002, leaving behind a TCE contamination problem. There are currently 480 vapor mitigation systems in the community. Mr. Little, a Ph.D. student in applied anthropology, has studied the human dimensions and social impact of VI on the Endicott community, and the application of this information to policy and regulation.

Mr. Little described some emerging themes of his research, based on 35 completed interviews out of 60 to 100 planned. The community is not homogenous, he said; there is variation in community members' feelings about and involvement with the issue. Community members are concerned about health risk and property devaluation, and also that the community of Endicott is "dissolving" since IBM left the community. Mr. Little found that diversity in perspective was related to subject's age.

The interviews revealed multiple lines of evidence of concern and frustration among community members. These included: contesting science and/or expertise; uncertainty (about the health risk and about the community's future); criticism of industry and government; and property devaluation. Mr. Little said that the tools of social science can be used to answer questions about issues such as local understanding of the social impact, the perspective of residents who do not take action, and the causes of community frustration and concern.

Mr. Little called the Forum a positive step in VI governance. Risk assessment and risk communication should be considered in the context of the actors, rules, mechanisms, and processes affecting the understanding of both risk analysis and how actions are taken. Mr. Little noted that public involvement is needed in the development of policy leading to pluralism and collective decision-making, as is a synthesis of the technical and social sciences.

Breathing and Drinking VOCs in Hopewell Junction, NY

Debra Hall, the founder of Hopewell Junction Citizens for Clean Water, noted that while the amount of information on VI has "ballooned" in the last five years, increased knowledge has not taken away residents' anxiety. Ms. Hall's home was the first of approximately 17 homes tested in Hopewell Junction in 2004 using the TAGA mobile laboratory. She said that she was amazed that results were available right away. VOC levels in the computer room, family room, and laundry room, were all above the NY State guidance of $5\mu g/m^3$. Ms. Hall found the variation in VOC levels in her home surprising, particularly that levels were higher in the upper floor than downstairs.

Ms. Hall recommended that if a home has VI, regulators should put a unit in the home to protect the residents, since it costs about the same to measure the home as to install a mitigation unit. She said that residents do not want to hear that "it's okay" that they have "a little bit" of a cancer-causing chemical in their home. Ms. Hall said that she would like to see agencies mitigate every home; communicate with residents; continue testing structures; retest the mitigation units; and hold polluters accountable. She also advised that regulators should clean up the source as best as possible; inform tenants; develop a law to enforce mitigation; install systems with alarms and test them yearly; and fund mitigation from the Superfund tax, which she believes should be reinstated.

Lessons Learned from the Chillum TCE Site, Maryland

Ms. Teddie Lopez, Washington, DC, discussed her VI experience at a site in which gasoline migrated into groundwater years after the 1989 release of gasoline at a nearby Maryland gas station. PCE was also found in the groundwater, and the EPA Superfund Program became involved. In October 2001, EPA was asked to take over responsibility for the investigation. EPA subsequently ordered remediation, namely, expanding operation of the mitigation system at the gas station.

Ms. Lopez said that several issues divided the community, and that each block in the neighborhood had different concerns, e.g., PCE, gasoline + PCE, gasoline, the treatment system, and groundwater. Legal issues, including a class action suit, and issues of influence / disagreement associated with the local citizens' group, meant that consensus was not always achieved among the more than 350 households involved.

Ms. Lopez noted that other contributing circumstances included conflicts with the State of Maryland (e.g., although the release occurred in 1989, no law required notification); the presence of cross-jurisdictional contamination; a contentious relationship with the gasoline company where the spill originated; issues of trust with EPA (e.g., EPA did not require the Maryland Department of the Environment to be present at community meetings); the technical complexity associated with two overlapping plumes; and the fact that two EPA programs were involved in the investigation. Some relevant process issues included a lack of timely response to citizen requests (e.g., replied to once a month instead of as received); a misconception of EPA's authority (e.g., the citizens thought EPA could make all the players come to the table); that public meetings, availability sessions, and comment periods were not always required; issues

with technical protocols and data review; and a misunderstanding of the process (e.g., the citizens just wanted testing, and did not want to have to wait for a protocol to be developed).

For community involvement in VI issues, Ms. Lopez said, there is a challenge in getting the message across. It can be difficult to disseminate information, as not all residents have email, and not all will come to scheduled meetings. Similarly, a highly technical information packet may not be the best way to reach residents, as they may not read it in its entirety. Based on the Chillum site experience, Ms. Lopez said the lessons learned were: "communication, communication, communication"; get the residents involved as early as possible; answer the where, what, why, when, and who; and realize that all residents will want their houses to be tested.

Q&A and Discussion on Community Case Studies

A participant asked Ms. Lopez if there had been a difference in response after the class action suit was filed. Ms. Lopez said that there was no difference in EPA's response. While the community groups were initially somewhat concerned, it turned out that the lawyers' presence was beneficial to all present.

A participant asked Ms. Hall if treatment was provided for homes that had their own wells. Ms. Hall said that within a few months, EPA had installed point-of-entry treatment systems, and now tests the water every three months. Residents feel better knowing that the filter removes contamination, she said, until they ultimately are able to get water from somewhere else.

Noting the variety of things that need to be addressed in order to allow sampling, e.g., dry cleaning, a participant asked the speakers about the level of awareness and concern in the community regarding background exposures. Ms. Lopez said that not everyone in Chillum was aware that background may be a problem, and that some of the things removed when sampling was underway proved to be a surprise to residents.

A participant asked the panel members for insight into why some people want testing and others do not. Ms. Hall said that some care more about resale value. If there are no illnesses in their family, they would like to know that they could sell their house, e.g., if they are depending on income from the sale for their retirement. Some people are lazy, scared, or just do not want to know, and do not realize that there are solutions. Ms. Lopez agreed, and said that some people did not want to be bothered. They felt that as long as their house was not contaminated, and they were safe, it was not a big deal. She noted that some houses in the area have been sold, but the buyers were not informed of the VI problem. Mr. Little noted that some people have mitigation systems even though they do not know the pre-mitigation levels. He said that a large knowledge gap may contribute to residents' sense of uncertainty. Mr. Siegel said that trust is the number one issue related to testing, e.g., immigrants may not trust the government due to their lack of trust of their home country's government. Regulatory agencies can work to overcome this lack of trust.

A participant asked the panelists to comment on the statement in a recent NAS/NRC paper on advancing risk assessment that stakeholder involvement needs to be an integral part of risk-based decision making. Ms. Hall said that affected parties can provide very important information,

e.g., on what works, what does not work, and how to gain access to people's homes. Ms. Lopez said that a protocol for getting stakeholders involved would be useful, noting that in Chillum, even when a neutral facilitator was used, some people did not believe the data, and still wanted testing. Mr. Little commented that early involvement and increased transparency may reduce a community's expectation of what an agency can do. Mr. Siegel said that if residents attend a couple of meetings, they may learn a little, but can become frustrated. With tools like technical assistance grants, however, communities can learn enough to begin to play a constructive role. He also said that with patience, government can learn that communities have something to offer.

Sampling and Assessment Session (Kathy Davies, Moderator)

Understanding the Conceptual Site Model for Vapor Intrusion into Buildings

Dr. Lilian Abreu, Civil/Environmental Engineer, Geosyntec Consultants, Santa Barbara, CA, set out to present three areas of information on the conceptual site model (CSM): to introduce key components of the VI pathway with the CSM; to provide an overview on VI fate and transport processes; and to present a modeling analysis to illustrate the use of different CSMs.

The CSM is a simplified description of a complex real-world system that is useful for site investigation planning, data interpretation, and as a framework to assess potential exposure to site contaminants. The CSM considers these aspects of the source: position (in groundwater or soil, which can be different in different locations, e.g., a variable distribution of soil gas), size, composition (e.g., chlorinated, petroleum, TCE, etc.) and concentration. Regarding the VI pathway, the CSM considers site lithology (i.e., homogeneous, layered or heterogeneous), groundwater capillary fringe effects (which limit vapor migration), biodegradation (aerobic vs. anaerobic), and pressure effects (e.g., air flow variations: from soil to building, from building to soil). The receptor component of the CSM is affected by building use (industrial, commercial, residential), occupancy, building construction (size, basement or no basement), and ventilation rate.

Regarding vapor fate and transport mechanisms, Dr. Abreu said that the gas phase transport is dominant. There is partitioning into the vapor phase and diffusive transport due to the compound's physical properties and differences in concentration. Advection occurs due to pressure differences. Recalcitrant contaminants do not biodegrade. Indoors, there is mixing of air and the contaminant, leading to different concentrations in different rooms. Dr. Abreu presented simulations using different CSMs to evaluate the effect of various site conditions on the VI pathway. She said that the attenuation factor is a defined parameter used to characterize the significance of the VI pathway, i.e., the amount of contaminant in the source that enters the building. The attenuation factor is the indoor air concentration normalized by the source concentration. Lower values are "better" in that they indicate less VI.

Source depth and building type are also considerations in the CSM. Dr. Abreu said that assuming all other factors are the same then: a) An increase in source depth results in a decrease in the attenuation factor for sources located directly beneath the building; b) Attenuation factors for buildings with basements are slightly higher than for slab-on-grade construction, because the latter type is farther away from the source.; c) An increase in lateral distance from the source

leads to a decrease in the attenuation factor. This decrease is greater for shallow than for deep sources if the subsurface is homogeneous; d) Moist, fine-grained soils may act as a diffusion barrier (reducing the attenuation factor); e) Heterogeneous lithology can also affect the attenuation factor leading to variability.

Use of a CSM can help with planning and interpretation and with communication, Dr. Abreu concluded.

Ongoing and Planned Research at NRMRL-Ada on Gas and Vapor

Dr. Dominic Digiulio, Environmental Engineer, EPA ORD, Ada, OK, reported on a protocol for sub-slab sampling developed at NRMRL-Ada. Following the protocol, the researchers learned that there was tremendous spatial variability, e.g., up to a factor of 10 or 100, suggesting the need to take more than one sub-slab sample; the highest concentrations were not necessarily in the center of the slab, and were correlated with soil gas concentrations outside the home; and there was some temporal variability, but only up to a factor of 2.

NRMRL-Ada also developed a method of looking at VI using radon as a tracer, or using VOC degradation products when available. Dr. Digiulio noted that just because a chemical is found in all areas does not mean there is VI. NMRML-Ada also found that soil gas concentrations outside a building did not correlate well with sub-slab concentrations. In that case, there could be a VI problem, but it would not be known, he said. The researchers used a mobile geoprobe unit for soil gas sampling. The PRT Sample System allows them to collect deep soil gas samples (up to 50 ft) very rapidly rather than by installing permanent probes. There is good correlation between measurements in sandy soils with a dedicated probe, but this correlation needs to be checked in silty soils.

Researchers at NRMRL-Ada also studied a passive diffusive sampler and its correlation with the active collection of soil gas samples. In silty soils, the leakage was 100%, equivalent to what was being drawn from the soil. In sandy soils, there was only 0.1% leakage. A mathematical assessment was conducted that validated common sense, Dr. Digiulio said, to show a higher probability of leakage in tighter soils (e.g., clay).

Work on purge testing is ongoing at NRMRL-Ada; this work is necessary to verify that a steady state concentration has been established. The process of installing the probe disturbs the equilibrium in the borehole. If there is no leakage, one will see a slow increase in the concentration as a function of purge volume. However, it depends on the starting concentration. Concentration alone does not tell if a probe is leaking.

Case Study: Sub-slab vs. Near-slab Soil Vapor Profiles at a Chlorinated Solvent Site

Dr. Brian Schumacher, Chief, Characterization and Monitoring Branch, EPA-NERL, Las Vegas, NV, discussed Site 14 at Naval Air Station Lemoore. The purpose of the case study was to measure the vapor concentration profile and compare it to general model predictions. The site had a large TCE/PCE plume in groundwater from multiple historical releases. Dr. Schumacher's team used multiple soil gas probes at different depths, collecting 2-3 samples over a 3-day period, in order to get average results to generate the soil gas profile. They analyzed the samples

for TCE and PCE immediately at an on-site laboratory. They also measured levels in groundwater at some of the sites.

A model predicted diffusion as one moved away from the slab, and decreasing concentrations as one moved from the source toward the slab. The measurements agreed, showing a sharp decrease away from the slab into the open field and a decrease from the groundwater source to the slab or soil surface. About 40 feet from the original site, Dr. Schumacher said, the sampling got "non-detects" for both the profile and groundwater source. While the overall profile is consistent with the model predictions, the isoconcentration contours were steeper than the model had predicted. Dr. Schumacher cited the following contributing factors: the source is clearly finite (groundwater concentrations are not constant); the groundwater is relatively shallow; the site is a large building with limited exposed ground surface for vapor release; the plume at this site is mature and possibly receding; and possible variations in source strength and other site-specific factors (although none were found).

In conclusion, Dr. Schumacher said, there were: strong soil gas concentration gradients in the near-slab environment; gradients in groundwater concentration and across the water-soil gas interface; and soil gas and groundwater concentrations are possibly in a dynamic equilibrium. The implications for sampling and modeling are that samples should be taken as close to the edge of the slab as possible. Simplifying assumptions for modeling may not apply to the near-slab environment and different mechanisms for mass transfer may apply. In terms of future research, Dr. Schumacher said that long-term investigations are already underway. The studies include monthly sampling to look at seasonal variation; additional probes to fill in data gaps; groundwater sampling at each probe location; study of the impact of sampling and temporal variables on soil gas results; continuous soil gas monitoring during a major storm; investigations of the impact of purge volume; and examination of different tubing types.

<u>Using the TAGA Mobile Laboratory to Resolve Vapor Intrusion Issues: Interpretation of Multiple Lines of Evidence for Vapor Intrusion</u>

Dave Mickunas, EPA Environmental Response Team, Research Triangle Park, NC, discussed the use of the TAGA mobile laboratory. Five questions are relevant:

1. Is there subsurface gas?
2. Is it getting into the residence?
3. Is it from the subsurface, or from other sources?
4. If it is not, does EPA have the regulatory authority to address it? and
5. What analytical techniques are appropriate?

Use of the TAGA allows for better communication with residents, who can sit in the van, watch a monitor and see exactly what the operator sees.

Mr. Mickunas presented several examples of how the TAGA helped to resolve VI issues. In one case, measurements in a gymnasium showed three chemicals rising and falling similarly, which suggested they were all from the same source. In an adjacent house, the same three compounds were present. Upstairs concentrations were higher than those from lower levels, which suggested that the house was closer to the source. This does not mean that the house is closer tot

the source. It simply means that the gym and the house are being impacted from the same source. Moreover, since the basement is higher than the upstairs, the source is likely to be due to vapor intrusion. The gym was a single floor design and this relationship could not be tested there. The TAGA can also be used for monitoring for crawlspace contributions. At a TCE site in Region 6, for instance, monitoring showed increased contaminant concentrations in the crawlspace, suggesting VI. Another example came from Region 2, in which 60-second readings were taken from each room in a split-level house. Because the layout of the house was open rooms, contaminant distribution was generally consistent throughout the house; however, one small closet, where pipes entered the house, showed much higher levels.

The TAGA is also helpful in monitoring for lifestyle sources of contaminants, Mr. Mickunas said, noting that "everything leaks." In a home where both the garage and basement showed elevated contaminant levels, moving the sampling hose across the front of some storage shelves revealed high concentrations that could be traced to a leak from a container of substance that contained TCE. Another source of contaminants can be attached facilities. Mr. Mickunas described a case in which a building used by the local police was found to be a source, due to the use of a TCE-containing product for gun cleaning. In the case of a dry cleaner near an elementary school, where there was a suspected gradient in ground water, no PCE was found. The highest TCE concentration was found in the school boiler room, and was traced to use of a TCE-containing contact cleaner.

Use of the TAGA has identified other factors, including the effect of wind direction. For example, sampling at an apartment and a nearby dry cleaner showed an order of magnitude variation due to wind direction. The TAGA can also be used for monitoring for accidental or intentional releases. For instance, TAGA sampling located fresh fuel in a drain in the basement of one building, by identifying components using the GC/MS on board the TAGA laboratory that would have been absent from a 19-year-old spill.

In conclusion, Mr. Mickunas said that the TAGA can provide an excellent way to determine factors (lifestyle, geographic, etc.) that can interfere with sampling. It is the best possible tool for this kind of work. The TAGA has a good correlation with the 24-hour SUMMA canister, is less costly, and requires only one visit. If one considers investigating 10 homes per day, you would need 3 SUMMA canisters per house (subslab, basement, and first floor) at a cost of approximately $300 per SUMMA which results in a cost of $9000. However, the SUMMA sampling also requires mobilization cost, costs associated with the actual sampling, demobilization costs, shipping cost (~ $25 per SUMMA), quality assurance validation cost, report writing costs and you have only one (1) sampling point at each location for one (1) moment in time. With the TAGA, the costing is about $10,000 per day and costs associated with travel. Furthermore, you have continuous monitoring of the entire facility (room by room or survey of materials in the residence). If the monitoring takes 30 minutes and the compound concentrations for the target compounds are updated every second, you have 1800 results to consider. That is considerable more information than is provided by SUMMA canister sampling.

Empirical VI Database Background Indoor Air Review Updated J&E Spreadsheet Model: Some New Tools for Vapor Intrusion Assessment

Bill Wertz, New York Department of Environmental Conservation, Albany, NY, reported on the EPA work group's progress on technical update papers on the VI database, background, and Johnson & Ettinger (J&E) model. A key question when conducting a VI evaluation is how much of the observed concentration of a VOC in the indoor air is due to background sources, and how much is due to VI. Consumer products (e.g., cleaners, air fresheners, aerosols), building materials, combustion processes (e.g., smoking), and occupant activities (e.g., hobbies) can all contribute VOCs to the indoor air.

Based on a literature review and compilation of order statistics, a graph of background concentration vs. sample date illustrates that the background concentrations have been relatively stable since 1990. Prior to 1990, the use of TCE, PCE and other VOCs in consumer products was common, and consequently, background concentrations of those compounds prior to 1990 were much higher. Mr. Wertz recommended using the post-1990 data as more representative of current concentrations.

Mr. Wertz noted that for some compounds, the current background concentrations in indoor air fall within the risk-based concentration (RBC) range. Although VI of those compounds will increase the associated risks, installation of a vapor mitigation system may not reduce indoor concentrations of those compounds below the targeted RBC risk range. Mr. Wertz also noted that the background presence of some VOCs in the indoor air (i.e., BTEX compounds, PCE and 1,1,1-TCA) may lead to biased estimates of the VI attenuation factors associated with those compounds.

Mr. Wertz said that the 2008 VI database covers 41 sites in 15 states. Most of the calculated attenuation factors in the database are from groundwater to indoor air. Most of the buildings in the database are residential. A fairly small number of sites dominate the database. Regardless of the groundwater VOC concentration, one sees a three orders of magnitude range in VOC concentrations in the indoor air in structures above the groundwater VOC plume, making accurate prediction of the VOC concentration in the indoor air of any given building using exterior environmental data difficult. The database has a built in filtering function that allows users to compare data from their sites with database data from specific sites or geologic settings. The database is a "phenomenal tool" for use in estimating the range of indoor air concentrations one is likely to find when conducting a VI evaluation.

In summary, Mr. Wertz said that regulators have to factor in background concentrations, some of which exceed the RBCs. They need to realize that they may not be able to reduce the concentration of VOCs in indoor air below the RBC risk range. They also need to realize that it may be difficult to distinguish the impacts of vapor intrusion from those of background sources at structures with low concentrations of VOCs in the indoor air. He urged participants not to think in terms of points, but to think in terms of ranges.

Q&A and Discussion on Sampling and Assessment

A participant asked whether the TAGA probe went back to the vehicle. Mr. Mickunas said that it did. The participant asked how many TAGAs EPA had, and how use of them was prioritized. Mr. Mickunas said that there were three, one in Las Vegas, NV, and two in Edison, NJ, and prioritization is simply by "who needs it the most." The participant inquired about the cost of a TAGA survey. Mr. Mickunas indicated that a SUMMA canister costs $300, exclusive of shipping and cleaning. Because TAGA provides a constant picture throughout the residence, not just one room, he did not think the cost could be easily compared.

A participant asked whether there was a process for community-based groups to request the TAGA vehicle. Mr. Mickunas said that ERT works with different regional offices; regional officials can ask for assistance, which determines where the TAGA goes.

Regarding Dr. Schumacher's work, a participant asked whether the slab had an enclosed structure above it and how advection was considered. Dr. Schumacher said that there was not a building on top of the sampling site, so advection was not a concern. He pointed out that they were not really comparing the data to a model. Dr. Abreu said that another CSM model could be used to determine if the source stopped before the slab.

A participant asked whether filtering air on the intake of the HVAC system had been used in an attempt to lower concentrations below the risk range. Dr. Schumacher said that he did not think that approach had been tried. Mr. Mickunas pointed out that at low levels, the actual absorption process is not as effective as it would be at a higher concentration.

Noting that VI cases tend to have competent bedrock at 6 to 9 feet down, and that modeling tends to deal with a greater soil thickness, a participant asked if any research or case studies with bedrock close to foundations existed. Dr. Schumacher said that most sites on which he has worked have a reasonably thick mantle above the rock. He had one site with fractured rock and a spring at some distance, for which, instead of making a detailed installation to identify fractures, he sampled structures that existed between the source and the spring. Dr. Schumacher said that structure sampling is the best way to help people understand VI. Mr. Wertz pointed out that sub-slab sampling would be easier and less costly than drilling into bedrock. Moderator Kathy Davies noted that even fractures in weathered bedrock can retain integrity and act as a preferential flow path.

A commenter said that modeling work done at Brown University showed that flow rates are slow enough that the sub-slab is dominated by diffusion for typical flow rates. Dr. Abreu responded that even without advection, one will see a buildup of concentrations below the slab. There is a need to update the conceptual model with a simulation to provide better measurements.

A participant commented that the speakers have made the case that near-slab concentrations can significantly underestimate concentrations beneath the slab, and asked how one would sample if one suspected the presence of a vapor barrier, and wanted to avoid damaging it. A panelist recommended taking a sub-slab sample anyway, and then patching the barrier. Dr. Abreu recommended consulting an upcoming EPA document that will give information on site

conditions that can affect sub-slab sample accuracy, and noted that while one could sample deeper than the foundation, that could lead to an overestimate.

A participant asked whether EPA had used the TAGA bus to measure vinyl chloride. Mr. Mickunas said that EPA had, and could measure to 5 ppb, which is not quite as sensitive as TAGA is for TCE. He recommended using SUMMA canisters to measure vinyl chloride.

Community Stakeholder Breakout Session (Lenny Siegel, Moderator)

Mr. Siegel, the moderator, said that this session was a chance for people working in the communities to tell their stories. He then invited a number of community stakeholders to speak.

Peter Strauss, San Francisco, CA

Mr. Strauss is a technical consultant for the VI sites in Mountain View, CA. He referred participants to Technology Tree, an online, front-end, user-friendly tool for learning about the available types of environmental characterization and remediation technologies. It also contains links to more technical databases, and can be used to relay information to stakeholders and government groups, he said. Technology Tree includes an alphabetized list of technology, and can be searched using various criteria. Future plans for enhancement include updating links, adding basic VI technologies, and making sure that the technologies and charts are accurate and relevant.

Mike Schade, Brooklyn, NY

Mr. Schade is with the Center for Health, Environment and Justice (CHEJ), a nonprofit that provides organizing and technical assistance to communities around the country. Ironically, he said, he recently moved to a new neighborhood, Greenpoint, which has VI problems. The area is primarily residential, but is surrounded by many polluting industries; Greenpoint is an "overburdened community" in terms of its industrial legacy. Most Greenpoint residents are recent Polish immigrants. Mr. Schade said that the community is not well-organized, and the residents not receptive to testing, due to property value concerns, cultural and language barriers, and the perception that the entire area is contaminated.

It has been estimated that 17 million gallons of oil (an amount greater than the Exxon Valdez spill) were spilled in Greenpoint from the numerous refineries that have been located there since 1870. A creek that runs through the town is also a major problem. The State started investigating VI related to the oil spill, and then discovered other problems, including chlorinated solvents. There are four or five responsible parties, he said, and TCE and PCE have both been found. The State has documented soil, soil gas and groundwater contamination, but has only tested 12 of 58 homes to investigate indoor air.

Mr. Schade said that New York State does not have the strongest standards for dealing with these chemicals. EPA Regions are developing different guidelines across the country, and the variance of standards between states is an important issue. There is some good news, Mr. Schade said, in that the State is moving forward with Superfund site cleanup and going after the responsible

companies. More VI testing is planned. Local and State policy makers are on board with more creative community outreach, door-to-door and phone outreach, and public meetings.

Dawn Philip, Brooklyn, NY

Ms. Philip works for New York Voice for the Public Interest, a nonprofit law firm, and focuses on environmental justice. She uses the community lawyering approach, a legal model that focuses on the community, to help stakeholders identify and solve problems in their own communities and foster leadership. Ms. Philip works on contaminated school sites in New York City, where the scarcity of land and the need for new schools mean that many new schools are being built on contaminated sites. This is also a racial and economic justice issue, with the population consisting of 85% students of color, and many low-income students as well.

The Manhattan Center for Science and Mathematics is a school that will be built on top of an old manufactured gas plant. The community learned about the nature of the site following a TV report. A parents' group is negotiating with the agencies involved in order to make the process as comprehensive and participatory as possible. Ms. Philip works to help get funding for environmental assessments. A draft analytical report is expected in a couple of months.

Ms. Philip commented that three points from the morning session had resonated with her: making polluters accountable, the need for environmental experts, and achieving trust in the community.

Mike Barry, Victor, NY

Mr. Barry discussed Modock Springs, a New York town where TCE was found in the public drinking water in 1989, forcing the entire town to switch to a new drinking water source. The plume from the site, Syracuse Sand and Gravel, is a mile long, and extends to a natural spring that was used as the public water source. Three private wells were also shut down, including Mr. Barry's, in which 250 ppb TCE was found, compared to the State's safe level of 5 ppb. An Environmental Impact Summary found that the contaminated spring also fed a number of streams with trout fisheries. Regarding VI, Mr. Barry said 24 homes were found to have actionable levels, requiring mitigation, resampling, or monitoring and six homes required vapor mitigation (sub-slab depressurization). In residents of homes located within the plume, 28 cancer cases (including 3 rare glioblastomas) and 15 cancer deaths were reported, resulting in the initiation of a cancer cluster study in June 2007. Mr. Barry said that, regarding effects on property values, assessments were reduced by 10 to 20% on 60 properties, 2 homes were sold for losses, and 4 houses were on the market and not selling. Owners believe they can sell their homes with full disclosure, he said, plus an explanation of the mitigation and what is being done.

Mr. Barry said that community stakeholders need to be aggressive with officials to get them to listen. He recounted how he contacted his State senator to increase the visibility of the town's situation. Mr. Barry has started a web page and email list to communicate with other members of the community, and the town has appointed a task force to act as a liaison with State agencies. A property value protection plan is being considered, which would address equity damage, reimburse homeowners with real estate losses, and provide city water for all affected homes.

John Andrade, New Bedford, MA

Mr. Andrade commented that problems with getting people to come to meetings and getting people to listen are common across the country. There are about 30 Brownfields sites in New Bedford, including the Morse Tools site, where contamination includes oil and VOCs. The responsible party, CBS-Viacom, is preparing to move out of New Bedford. Residents expected Federal or State involvement, but nothing happened, even ten years after the initial key report.

Local stakeholders applied for a technical assistance grant (TAG) in 2007, and used the TAG to prepare a fact sheet in English, Spanish, and Portuguese. The fact sheet breaks down scientific information into more accessible language. The stakeholders also established a speakers' bureau for outreach to individual groups, since attendance at meetings has been poor. They have had an environmental specialist prepare two reports to help them better understand the information. Some members of the community, e.g., the elderly, the less-educated, non-native English speakers, simply "do not hear" the technical information. Other activities of the group include building mailing and contact lists, and involving local and State officials. Mr. Andrade noted that when air sampling was proposed for eight homes, six of the residents would not let the personnel in, because the State had not communicated to the residents that sampling would be occurring.

Mary Moore, Phoenix, AZ

Ms. Moore discussed activities of the Community Advisory Group (CAG) in her neighborhood. The site is divided into three operable units; the State Department of Environmental Quality (DEQ) has the lead for the operable unit near Ms. Moore's residence, and has made no progress. The site has been on the National Priorities List since 1989. A VI study was first requested about six years ago, but has yet to be conducted by the State. Community involvement has increased following award of a TAG, and the CAG has made a presentation to community leaders and participated in an open house sponsored by the State DEQ. Ms. Moore noted that community attendance at the open house was limited. Using the TAG, the residents are holding public meetings, providing educational workshops, inviting experts to give technical presentations, and conducting observational audits of groundwater monitoring studies. The CAG is seeking access to a regional flow model and the site health and safety plan from Freescale Semiconductor, the company now responsible for the site.

Jane Horton, Mountain View, CA

Ms. Horton purchased her home in 1975. It is across the street from the MEW Superfund site and is currently undergoing TCE VI remediation. She noted that indoor air testing was never offered, discussed, or explained until 2002, when she had lived there for decades. Because the groundwater plume had stopped in the middle of the street, her home was deemed ineligible. A re-drawing of the plume made her house eligible for testing and remediation, which was then installed. Ms. Horton noted that EPA reached out to the community after the plume was redrawn.

The power to effect change happens due to the efforts of associations or groups, Ms. Horton said. She proposed that the regulatory agency should be obligated to help form and support

community groups where they do not exist. She also suggested that indoor air monitoring should be mandatory for residents living across from or on top of a Superfund site, or residents who know that TCE has been spilled or dumped. Ms. Horton urged agencies to listen to anecdotal information from residents about dumping. She also said that if indoor air contamination is found, sampling should continue until the groundwater is cleaned up.

Barry Durand, Weaverville, NC

Regarding a site on the saddle of a mountain near Asheville, NC, Mr. Durand said that he had experienced some difficulties in communication with personnel from EPA Region 4. He said that he would like to see a uniform standard across the Regions so that EPA personnel would use the same methods and practices and achieve the same level of expertise.

Carol Meschkow, Long Island, NY

An underground aquifer is the sole source of drinking water on Long Island, Ms. Meschkow said, and there are special groundwater protection sites. In 2007, the State revisited registry and legacy sites, including Plainview on Long Island. The local Water District had been remediating TCE for $5 million a year, at taxpayers' expense, but the levels were not decreasing. The State acknowledged that there could be two sources of contamination from industrial parks on the spine of the island, but could not delineate the plume. Residents were concerned that if the plume traveled to the southwest, it would underlie a cancer cluster, the community park, and the high school. Residents were also concerned about the effect of contamination on their property values; some either did not want to know or did not care, Ms. Meschkow said. Nevertheless, a few people wanted to learn and became the backbone of environmental efforts in the community.

Ms. Meschkow reminded participants that they know their own communities, can see what is happening, can use common sense without the facts and figures, and should be persistent.

Maggie Motheral, Philadelphia, PA

Ms. Motheral described her experience related to the excavation of a railroad site, where dumping had taken place, near her home. She experienced symptoms (coughing, weakness, cognitive problems, difficulty breathing) and left her house. She is still displaced and symptomatic, and has been working on her own. Ms. Motheral said that the city had refused to investigate the site. She cannot afford sampling, and has been unable to find anyone willing to carry it out. Ms. Motheral has recently connected with some environmental activists.

General Discussion

A representative of HabitatMap.org offered information to participants regarding this website, an online community map that can be of help to grassroots organizers.

Mr. Siegel summarized three things that he heard during this session: a call for uniformity among the states and the standards; the fact that some communities do not want to allow sampling in their homes; and concern with property values. On the latter, he noted that some people want to recover the value of their home, while others do not want VI mentioned for fear it will lower the

value. The focus on property values may be because they are an immediate effect, whereas health effects are more uncertain, taking a long time to emerge.

Debra Hall of Hopewell Junction, NY, said that it was clear that Hopewell Precision had polluted the town. Nevertheless, the company filed to lower its property assessment, and the assessment was lowered by 80 percent, from $3 million to $500,000. Ms. Hall said that she, as a resident, could not get her property assessment lowered until she took action, first filing a grievance and then going to small claims court. She asked the assessor for a reduction of 40 percent (half of what was given to the company), and received it. Ms. Hall suggested that perhaps others could follow this route until there is a common standard.

Mr. Durand said that stakeholders in all the Regions should have the same level of knowledge. He said that he was encouraged by the rational, concerned discussion at this Forum. Mr. Durand cited problems with the chain of command at EPA Region 4, claiming that an EPA team member onsite suggested that homeowners were partly to blame for the decrease in property values because they brought up the issue of VI contamination. Mr. Durand said that the frustration and distrust seemed to be isolated issues, and urged EPA to properly prepare the on-scene coordinators and to give homeowners a means to approach the Agency.

Mr. Strauss noted that, with aggressive clean-up, the diminution of property values does not have to be permanent. He urged activists to concentrate on getting clean-up done as quickly as possible.

Ms. Horton agreed that there seems to be a large difference in competency among EPA personnel, noting that she has a great resource in Region 9. She noted that when she initially spoke to elderly residents in Mountain View, they said that they "hate" EPA, and they worry that the "good person" with whom they are working will leave. Uniformity across the agency is needed, she said. Regarding property values, Ms. Horton said that while a lower assessment is good in that it leads to lower property taxes, she still wants the polluters to be held responsible. Their stockholders are not losing any money because her house is polluted, she said.

Mr. Schade said that it was interesting to see the commonalities in the afternoon presentations. He asked the group to consider several questions: How can we strategically work together? With a new President and new EPA Administrator, what national policy changes would we like to see to assure VI is a priority for EPA? What do community and environmental groups think EPA could do better regarding VI on a national level? Mr. Schade stated that the polluters, not the taxpayers, should pay for cleanup. CHEJ will be releasing a big report that will put pressure on EPA to reauthorize Superfund, and is looking for groups to partner with at the release. Mr. Schade noted that VI chemicals are being used despite health concerns, and asked whether stakeholders could push for bans on these chemicals.

Mr. Andrade indicated that he had prepared a petition to the Obama administration requesting $300 million in funding for the Superfund bill. He also suggested that brownfields and Superfund site cleanup could be one area that the President could consider in his plans to create new jobs.

Lisa Jacob, a consultant, asked participants for input on the best format for involving the community, since speakers had suggested an open-house format might not be the most helpful. A participant suggested that community organizers could distribute plain, simple flyers that will help get people to the meetings. A participant noted that people want transparency, and suggested holding a large group meeting before holding anything smaller, because small meetings can seem like a "divide and conquer" approach. Another participant noted that people can be educated by their neighbors, and urged organizers to be willing to utilize different types of forums because people learn in different ways.

Ms. Moore said that a discrepancy in competency may also occur in State agencies and needs to be addressed. Regarding documentation, she said that when her local library was remodeled, the staff decided there was no room for Superfund documents, only binders of CDs. The loss of the early work was very troubling to the community.

Ms. Horton commented that when she held monthly CAG meetings of 300 to 400 people, she found it effective to provide participants with the contact information of people who could answer their questions and to pass out information as takeaways. The CAG also had the TAGA vehicle come to the meeting so people could see it. She noted that online posting of information is not a good way to reach the elderly. The CAG had a translator at the meeting for non-English speakers and used visuals to make concepts more easily understandable. Ms. Horton said that it was important to have a lot of variety and realize that people may not be able to stay for the whole meeting.

Mr. Siegel commented that some of the issues raised during this session may be changed by the new administration, such as completion of documents and pressure on EPA to make VI a priority. He reiterated that uniform guidance is needed across the country, and also predicted proactive Federal legislation on pollution prevention. Mr. Siegel noted that EPA's toxicology assessment for PCE would lower the acceptable level to 0.1 $\mu g/m^3$, and said a science-based protective standard is needed. The National Academy of Sciences (NAS) review of the document will be completed under the new administration, he said, and he urged stakeholders to communicate their desire for more protective standards to EPA and NAS. He said that the people working on the actual sites need to be involved at the national level to ensure that the toxicology is done correctly.

Government Breakout Session (Jack Kelly, Moderator)

Mr. Kelly, the moderator, explained that this session was divided into two parts: one for the states, and one for Federal Representatives. The states session included representatives from New Jersey, New York, Pennsylvania, Delaware, Virginia, and Maryland; and the Federal session included representatives from the Department of Defense (DoD); the U.S. EPA Office of Enforcement and Compliance Assurance (OECA); and EPA Regions 2, 3, and 6.

The session opened with the states' discussion of vapor intrusion issues. Mr. Kelly noted that each representative had been provided with a list of questions/topics to address. He asked each

representative to provide an overview of the State's program before moving on to these questions.

John Boyer, State of New Jersey

Mr. Boyer said that New Jersey has an existing vapor intrusion guidance document, and is in the process of adding to it. There is no separate program for vapor intrusion in the State – it is simply one of the pathways investigated. Most of the funding for the program comes through responsible parties.

Bill Wertz, State of New York

Mr. Wertz said that New York has been going back, or is planning to go back, to over 400 "legacy" sites in order to include vapor intrusion analysis as part of the investigation conducted under the Superfund program. To date, EPA has accepted responsibility for 55 sites; 70 sites needed no further action; and about 10% of all sites need mitigation.

Jim Shaw, State of Pennsylvania

Mr. Shaw said that, in Pennsylvania, vapor intrusion falls under the land recycling program – a voluntary cleanup program. The State initially attempted to address VI by capping State standards; however, that did not prove to be sufficient, and an additional screening process was established in 2004. All sites that have potential vapor contamination now have to undergo this new process in order to be approved.

Rick Galloway, State of Delaware

Mr. Galloway reported that the Delaware Superfund branch has developed a vapor intrusion policy very similar to the EPA policy. About 200 sites have been screened, and about 2 dozen are being actively investigated.

Gerald Grimes, State of Virginia

Mr. Grimes said that Virginia's remediation program addresses vapor intrusion, however, only the voluntary program has developed guidance. This guidance was developed to be user friendly, and is about four pages long with three tables. Virginia has about 500 VI sites.

Jim Carroll, State of Maryland

Mr. Carroll reported that Maryland has a voluntary cleanup program and a State Superfund program, in addition to the Federal Superfund program. The majority of VI sites come up in the first two programs. Screening of VI sites began in 1999-2000. The State follows EPA's VI guidance, as well as the ITRC VI document, and uses the New York standards for contaminant screening levels.

Q&A and Discussion on State Programs Overview

A participant asked what changes were being planned for the New Jersey guidance. Mr. Boyer responded that the section on remediation and mitigation is being updated, as is the section on screening levels. He added that there is also a website with information, documents, and an FAQ section intended to clarify some of the issues associated with VI.

Mr. Kelly wanted to know why New York and New Jersey were so far in front of this field. Mr. Boyer and Mr. Wertz both agreed that it comes down to one big case that garners national attention, noting that the government tends to respond to a crisis.

A participant asked whether any of the states have standardized statements of work that apply to sampling and/or mitigation. Mr. Carroll noted that Maryland has copies of response action plans that worked well to use as examples. Mr. Galloway added that Delaware uses information from building guidance documents.

A panel discussion followed, addressing the questions provided to the State speakers.

Question 1: Do you or can you take a mitigative action based solely on sub-slab sampling data; or do you need corroborative indoor air data?

New Jersey uses the multiple lines of evidence approach, as well as screening levels and an attenuation factor. Other considerations include environmental conditions that might influence the results, and special populations. New York also uses multiple lines of evidence, and does not rely exclusively on modeling or on a single attenuation factor. Preemptive mitigation is done in cases where the sub-slab concentration exceeds a certain level. Pennsylvania has a screening process for every site that has to go through the program; this process provides for the possibility of modeling the potential for a vapor intrusion issue. A standard attenuation factor is used, which is adjusted to site specific conditions. Existing guidance also provides that a project manager can go directly to mitigation when warranted. Delaware uses Table 2 of the EPA document to determine whether an investigation is warranted; then modeling, to evaluate the risk of vapor intrusion into a building. Virginia also uses a screening process, with levels based on attenuation factors for sub-slab, deep soil, and groundwater; these were derived using the EPA database. Maryland uses a screening process based on the EPA guidance and the ITRC document.

Q&A and Discussion on Question 1

A participant asked Mr. Wertz (NY) how variability between sites is incorporated into the screening process. Mr. Wertz replied that a decision-making matrix is used which takes into account both indoor air and sub-slab screening criteria, and dictates what action should be taken. The maximum concentration encountered during screening is used to determine whether action is needed.

Another participant asked whether the states ever encountered problems derived from using a guidance document, rather than regulation. Mr. Boyer noted that in New Jersey there are provisions that allow the State to require compliance with this guidance. Mr. Shaw added that,

in Pennsylvania, there is a requirement already in place to determine whether or not to take action; the guidance is used to determine how to address the issue – not to decide whether or not it should be addressed.

Question 2: Do you use attenuation factors to assess the need to take mitigative action? If yes, do you have or are you developing your own attenuation factors, or are you using attenuation factors developed by another organization? What organization?

Mr. Kelly commented that this question had been addressed in part during the discussion of question 1, but asked the representatives whether they had any further comments.

Mr. Carroll said that Maryland tries to balance sub-slab and soil concentration to decide whether to continue monitoring, but noted that this process has not been finalized. Virginia and Delaware do not require indoor air samples, but may occasionally request additional or stronger evidence. Mr. Kelly stated that whether or not indoor air data should be used was a big issue in Region 3.

Question 3: Typically, how much data (temporally and spatially) are needed to classify a home/business as no longer requiring further investigation?

Mr. Shaw (NJ) commented that every situation is different, so it is difficult to define a specific set of samples or data needed in every case. Mr. Wertz added that New York also does not have a "bright line" defined; typically, they would look for a band of two house widths from the impacted site, tied together with other environmental data. Houses with a sufficient presence of the contaminant in the sub-slab would be monitored for a minimum of three years. Pennsylvania considers the screening values and process; when the collected data meets the requirements of this process (at the source, and at the receptor), the project managers no longer need to evaluate for VI and can terminate the investigation. Delaware has no written policy, but would attempt to bracket the area around affected buildings, as well as examine a representative area for any exceedances that might trigger remediation. Virginia uses a screening process that includes both groundwater and subsoil samples, and requires that it be confirmed with another round of sampling. Maryland uses a PCE concentration of 18µg or below in commercial buildings, and a process similar to New York's for other mitigating factors.

Q&A and Discussion on Question 3

A participant wanted to know whether states sample a targeted compound, or begin with a wider range of volatiles. Mr. Carroll said that Maryland tries to develop a specific list, and noted that it is often difficult to distinguish the source of a contaminant; PCE, for example, could be coming from the subsoil, or from a nearby dry cleaner.

A participant asked whether mitigation systems are ever installed just to err on the side of caution. Mr. Boyer said that there was a case in New Jersey where a responsible party elected to mitigate based on very limited data on the extent of the groundwater plume. Maryland and New York also have instances where mitigation was done after only minimal sampling. In response to a question, Mr. Wertz confirmed that there are some instances when residents prefer to have their homes sampled first; however, in these cases, when samples come out clean mitigation may not

be offered. He added, in response to another participant, that there are definitely cases where homeowners do not want the mitigation even after sampling has demonstrated there is a problem. In cases where someone declines mitigation, they are informed that NJ State law requires disclosure of the sampling results to tenants or potential buyers.

Question 4: How do you address long-term operation and maintenance (O&M) of installed mitigation systems, particularly for non-enforcement sites?

Mr. Shaw (NJ) reported that O&M is addressed in the guidance document, as is ongoing mentoring and closure. New Jersey real estate laws require disclosure of a problem with a property, such as groundwater contamination or the installation of a mitigation system, to a potential buyer. Mr. Wertz said that New York has not yet closed any systems, but would include sampling before closure to confirm that the source has been cleaned up. He added that a fair number of people do not want the sampling, so as not to have anything to disclose. In Pennsylvania, the minimum requirement after installation is to demonstrate that the system is working. The responsibility for long term O&M typically lies with the entity that conducted the remediation, unless a different agreement was made in advance. The Covenance Act also ensures that maintenance is performed as required. In Delaware and in Virginia, an O&M plan is required as part of the site closure procedures. In Maryland, data must be provided to show the mitigation system is no longer needed before it can be closed; for many sites, the long-term solution to mitigation is to remove the source/cause of the VI issue.

Q&A and Discussion on Question 4

A participant asked how the states enforce disclosure of a VI problem to future property owners. Mr. Carroll replied that, in Maryland, if an owner fails to disclose, they become the responsible party; there are tools in place to enforce disclosure.

Another participant wanted to know whether indoor samples are required to close a system, if they were not used to begin mitigation. Mr. Boyer said that in New Jersey indoor sampling is generally not required in areas where OSHA may be applicable. Mr. Galloway added that Delaware also does not require indoor air samples; and Mr. Shaw noted that Pennsylvania does not have the authority to regulate indoor air quality. A participant recommended re-thinking the issue of sampling indoor air as part of the information needed to verify that mitigation is, indeed, working.

A participant asked whether there are any techniques or methods that can account for pressure differences in sub-slab samples. Mr. Wertz said that New York has a standard process to ensure there is sufficient pressure when the system is running all the way beneath the slab.

A participant asked for comments in how each State addresses contamination issues, such as when TCE may cause an indoor air concern that could exceed the State's standards. Several of the states represented (New Jersey, Delaware, and Maryland) would use the OSHA standards. Mr. Wertz (NY) commented that OSHA standards were not designed to be risk protective; New York has established its own guidance value for mitigation. In Pennsylvania, the person who changes the use of a site (e.g., from non-residential to residential) becomes responsible for

making it protective to that level. He added that Pennsylvania does defer to OSHA standards where they are applicable. A member of the audience commented that OSHA regulations also have a right-to-know component, and noted that it is not quite accurate to say that if OSHA covers a facility, it does not have to be tested for VI.

A participant asked about Pennsylvania's environmental covenant, specifically who would be informed of a land-use change. Mr. Shaw replied that the covenant makes disclosure enforceable because it is attached to the land along with the deed. Additional regulations are being developed to ensure enforcement of this program.

Mr. Kelly noted that there were two more questions; however, they were addressed during the previous discussion. He concluded the states session and moved forward to the Federal session. Federal representatives used similar questions as the State speakers to guide their presentations.

James Miles, EPA, OECA

Mr. Miles summarized two main lessons learned from various remediation cases in Region 3: 1) scientific uncertainly allows opportunities for different parties to claim that data support their point of view; and 2) EPA has a good enforcement tool, RCRA, and can issue an order for remediation in cases of "substantial endangerment to health and/or the environment". Unlike CERCLA, RCRA does include petroleum products. Future plans include working with the program offices to add effective enforcement tools as part of their housing guidance development.

Richard Mach, DoD

Mr. Mach presented an overview of the DoD's environmental program, which is managed by the Army Corps of Engineers and oversees $1.5-$2 billion/year in restoration projects. Vapor intrusion is a pathway of concern as it impacts human health. The Department of the Navy alone has about 3700 sites in various stages of investigation, mitigation/remediation, or already closed out, and is committed to achieving protective remedies on all sites. On those sites with volatile chemicals that could get into indoor air and affect human health, that is incorporated into the investigation and eventual remediation. Not all branches of the DoD have written policies in place, but a manual is being developed by DoD to incorporate the existing policies and guidance documents. Each department is also working on its own, more detailed guidance document.

Jack Kelly, EPA Region 3

Mr. Kelly said that he became involved in vapor intrusion by trying to answer some questions about TCE, and provided an overview of the Region 3 VI program. Region 3 does not, in fact, have a specific program or guidance for VI: it is run by RCRA and Superfund, and allows the flexibility of using guidance developed by other states. There is a framework (not guidance) document being developed which will be publicly available and include information on health risk, a decision-making matrix, and technical and policy questions and answers. The remedial program in Region 3 has 96 sites with VI issues, ten of which are very high priority. The removal program has about ten sites, five that came through residents or the state, and five

referred by the remedial program. In the remedial program, though not in the removal program, Region 3 does have a policy of returning to check closed sites.

Michael Sivak, EPA Region 2

Mr. Sivak became involved in VI after providing risk assessment support to a project in New Jersey. The Superfund program's approach focuses on how to make decisions based on the interpretation of analytical results. Two types of matrices are used, for carcinogenic and non-carcinogenic chemicals. There is also language in place that explains the potential risk factors and provides additional information that can be used as part of the decision-making process. The program also uses state guidance documents, particularly those developed by New York and New Jersey; and is in the process of formalizing a SOP for the steps in this process. Vapor intrusion is not being addressed by any specific programs in Region 2. There is a regional decision team that discusses referrals from states, and which is used as a tool to identify VI issues at new or existing sites. Region 2 is also in the process of revisiting existing sites to find out whether anything was missed, and is formalizing a way of recording how each site was analyzed and closed out. Communication is ongoing with both DoD and the states in order to compare methods and processes.

Sai Appaji, EPA Region 6

Mr. Appaji became involved in vapor intrusion while trying to keep up with the sites in Region 6. There are only a few sites in the Region under review, so there is not a comprehensive policy or guidance in place; instead, Region 6 relies on the national guidance, and does not have a specific program for addressing VI. There are several sites referred from RCRA under the remedial program, and additional sites in New Mexico and Texas. There are no plans to return to closed sites. Communications with the DoD and other states vary, with some states being more proactive than others.

Q&A and Discussion with the Federal Panel

Mr. Mach, responding to a question about communications with the DoD, noted that there are good communications and information exchange between most states and DoD sites. A participant commented that five-year reviews are an effective tool for keeping communications open and learning more from existing sites.

Mr. Hagel asked the panel and audience what the EPA Regions need from EPA headquarters. Mr. Appaji (R6) said that risk assessors would like more clear direction from HQ to facilitate a consistent approach to all sites in the region; as well as more information on inhalation risk values. Mr. Sivak (R2) said that more FTEs are needed to conduct this work, and more information on existing strategies on determining how and when a system can be closed. Mr. Kelly (R3) said that from the removal perspective, needs include more information on exit strategies; indoor air guidance; more information on the VI database and evaluation of the data; and parameters on risk assessment and management. Mr. Mach added that the DoD was concerned that there was no EPA policy on VI when it began developing its own policy, adding that it would be ideal to have a national guidance document.

Mr. Hagel then asked the participants to address the issue of mitigative action based solely on subsoil vs. indoor air samples. Mr. Appaji (R6) and Mr. Sivak (R2) both replied that it varies by state. Mr. Sivak added that this is a more complicated issue in removal than in remedial sites.

Mr. Hagel asked whether the regions had any specific needs from ORD on long- and short-term research and development. Mr. Sivak (R2) replied that evaluation of data with seasonal influences, analyzing existing data for seasonal variability, and acute and subchronic values for inhalation risk would all be useful. Mr. Kelly noted that more data are needed in the vapor intrusion database on indoor air and subsoil sampling.

A member of the audience asked the panel members what had been the most challenging issue in their program. Mr. Miles (EPA/OECA) said it had been working with regional counsels; Mr. Appaji (R6) noted the lack of existing guidance; Mr. Sivak (R2) said it was deciding on exit strategies; Mr. Mach (DoD) mentioned coming to agreement from a working team on the data to collect; and Mr. Kelly said it was balancing consistency while allowing states sufficient flexibility.

TUESDAY, JANUARY 13, 2009

In his opening remarks, Mr. Hagel acknowledged the poster presentations from Monday evening. He noted that speakers' slides will be posted on the registration website within 1-2 weeks and that the proceedings would be posted in 4-6 weeks.

Government Breakout Session Report

Jack Kelly, On-Scene Coordinator, EPA Region 3, Philadelphia, PA, reported on the government breakout session from Day 1. It consisted of two sessions, State and Federal, for which he, as the moderator, had prepared questions in advance. The state speakers reviewed their programs, described the procedures they followed for making remediation decisions, and noted the attenuation factors they used. Some issues discussed included whether decisions can be based on sub-slab measurements alone, how to classify structures that no longer require remediation, and how to address long-term operations and management. Mr. Kelly noted that New York and New Jersey are at the forefront of the VI issue, and have extensive guidance.

Summarizing the state representatives' presentations, Mr. Kelly said that all indicated they used multiple lines of evidence; a variety of attenuation factors were used; all would use sub-slab data alone for mitigation (which he characterized as a surprise); the amount of data needed to stop remediation depended on the site-specific situation; and each had its own process for operations and maintenance. He said that the evaluation of closed-out sites and the community involvement process were not discussed.

Federal agencies were represented by EPA and the Department of Defense (DoD). EPA HQ will be working with the Regions on enforcement at sites where it has been initiated or is contemplated. DoD has a large number of VI sites, and a robust approach to addressing it. DoD will soon be releasing a VI handbook. Regarding EPA Regions, Mr. Kelly noted that they have individual VI guidance. Regions 2, 3, and 6 rely on the 2002 HQ guidance, and can look at state

guidance. Region 3 is developing a VI framework. Mr. Kelly opined that Region 2 probably has more experience and policy for addressing VI sites than do the other Regions. Region 3 has 96 VI sites requiring evaluation; ten are high priority, five to ten require removal, and ten to 15 require Superfund removal. Region 6 has five or six sites in the RCRA program. Regarding what the Regions would like to see from HQ and ORD, they indicated national guidance that allowed for flexibility at individual sites and consistent sampling procedures. Mr. Kelly said that the Federal representatives said that action could be taken based on sub-slab data alone, if action was considered essential at the site. He also noted that the Region 3 managers said they would prefer exposure data, but agreed that an argument could still be made to act on sub-slab data.

Community Stakeholder Breakout Session Report

Mr. Siegel reported that about ten people told their stories related to VI. He noted that most had expressed frustration with government agencies. A number of participants called for uniformity in VI programs across the country, noting variation in the approach among regions and states, and said they would like a model to use as the standard. One stakeholder from North Carolina believed that other EPA Regions were doing more than Region 4 was, and was pleased to hear that they indeed seemed to be.

Noting the MCL of 5 ppb for TCE in groundwater, Mr. Siegel pointed out that the action level or screening level for indoor air is "all over the map," which is very confusing to stakeholders. People would like to have a starting number, recognizing that site-specific factors will have an influence. Guidance for PCE is also needed.

Mr. Siegel said that the issue of property values was a two-edged sword. On one hand, activists say that they want their assessments lowered or seek reimbursement for the amount lost. On the other hand, representatives from some communities told of residents who would not cooperate, e.g., would not allow testing, for fear that it would show contamination and lower their property values. Mr. Siegel said that environmental regulators typically do not address property values, but the issue is central to how stakeholders react to VI and guidance should take it into account.

Polluters are not being held accountable at a number of sites, according to community stakeholders, Mr. Siegel said. The regulators perceive that the polluters do not have the money to pay for cleanup; however, the companies are still in business. Another issue is how to involve people and make community meetings successful. There was variation among the communities in effective methods. There are few people in the entire country with VI expertise to work with communities, compared to other issues, like groundwater, so accessibility to independent experts is limited. Mr. Siegel said that it would be valuable to compile the data on all VI activities across the country, as the ITRC surveys are the "tip of the iceberg" in what is needed. There is no organizing body or communication forum to bring all the people affected by VI at all the sites across the country together. Mr. Siegel asked participants to help put people in touch with him and said that his goal was to keep people informed.

<u>Q&A and Discussion on Breakout Sessions</u>

A participant asked whether the state representatives had addressed voluntary cleanup programs and their potential effect. Mr. Kelly said that while most presenters were involved in voluntary

cleanup programs, the issue was not addressed in detail. Another participant said that New York State had revisited 420 sites, requesting participation ranging from paperwork to sampling. New York is finding problems, including significant issues at a number of sites, and has also admitted to some mistakes. A representative from Virginia said that its relatively young program has looked at VI for all sites examined, and has no plans to revisit them. Mr. Shaw from Pennsylvania said that its voluntary program had been in place for 13 years. Due to budgetary and staffing limitations, Pennsylvania has no intent of revisiting sites, unless a specific issue or problem arises. Mr. Kelly said that ITRC has a report on revisiting sites, which is available on its website. Mr. Siegel said that he thinks what New York has found would be likely in all states. He also requested that the states communicate to the public when they cannot do things due to budgetary reasons, so that the public can fight for that funding.

A participant asked Mr. Shaw whether the Pennsylvania DEP was addressing the standards, noting that the screening level for TCE in groundwater was thousands of times higher than any other standard. Mr. Shaw said that the standards are peer reviewed, based on sound science, and conservative. They are at levels that would include sites where there could be a significant problem, and those levels have been found to be appropriate.

Ms. Hall asked how realistic it was to expect that a technique would someday be developed for cleanup of the aquifer so that mitigation systems would no longer need to be used in homes. Angela Carpenter, Region 2, noted that in Ms. Hall's area, there was an extensive plume in less-than-ideal lithology for remediation. Determining how to deal with the contaminated aquifer will be a very long process (20 to 50 years), so remediation systems will remain part of the approach to VI for a long time. Ms. Carpenter said that standards on how systems are installed are needed, and that remediators need to address how the systems affect home value. Moreover, there are VI problems at low groundwater concentrations, which still need to be addressed. Another participant noted that aquifer clean-up depends on the nature of the site. If 10-20 ppb of TCE in the groundwater is triggering mitigation, clean-up is difficult, given the mass stored in the aquifer.

A participant commented that eventually, a dilute plume will flush itself, but this may take a long time; a more aggressive source removal approach would be needed to assure mitigation was no longer needed. Mr. Siegel said that there are three kinds of VI sites: where groundwater is addressed, not addressed, and not identified. In some cases, remediation is necessary, but in others, such as in New York City, groundwater is not an important source of drinking water, so it is less important to look for the source of contamination.

Regarding turning off remediation systems, a participant commented that while there may come a time when the levels of the contaminant for which the system was intended are low enough for it to be turned off, the system is also helping with other contaminants, such as radon. The participant suggested that 90 percent of the people using remediation systems are getting more protection from radon than from VOCs. In addition, he urged EPA to develop a standard method for installing of remediation systems, and to train mitigators, as had been done in the early years of the radon program.

A participant from Region 1 noted that he had installed a number of sub-slab ventilation systems, and was shocked by the cost to do so properly under the Superfund program. He wondered whether it would be possible to better coordinate with the radon program regarding upfront assessment costs ($100 for radon vs. several thousand dollars for VI) and installation (a few thousand dollars for radon vs. some $30,000 for VI). Another participant commented that VI systems may well be put in every house that is built from this time forward, noting that builders get 60 percent of LEEDs green building points for putting active ventilation systems in new homes, which would address a number of contaminants.

Mr. Durand said that it was refreshing to hear technical information at this conference about which he had not previously heard, e.g., the need for multiple sampling. He opined that the people with whom he deals in Region 4 are authoritative about their opinions, but said that he found that those opinions do not match what he has heard at the Forum. He stated that while he had made an argument for multiple testing to someone from Region 4, the person was not receptive. Mr. Durand said that the Forum has changed his opinion about how EPA handles VI, and stressed the need for standardization and common knowledge across EPA's Regions.

Community Involvement Challenges at Vapor Intrusion Sites

David Polish, a Community Involvement Coordinator, EPA Region 3, Philadelphia, PA, said that if one does not understand the science, it is difficult to communicate the science to the public in terms they understand. He stated that it is important for communicators to sit down with the scientists and learn the technology being used at a particular site.

Property value is one of the challenges with VI, Mr. Polish said. He dealt with the property assessment issue at a gasoline spill site where the community pushed to have their property taxes reduced. Their reasoning was that since the spill reduced their property values, they should not have to pay those taxes. Some people pushed to have the assessment "zeroed out," with no consideration of the house's role as collateral and the effect of a zero value assessment on getting loans. Almost immediately after the re-assessment to zero, some residents came to Mr. Polish and complained about their inability to get loans. However, EPA had no power to change what had been done by the community. After remediation and cleanup, property values did rebound, and the normal assessment was reinstated.

Mr. Polish addressed a number of challenges in VI. New sites, he said, are a positive challenge, because they provide the chance to introduce the concept of VI to the community at the beginning of the process. Old sites, on the other hand, are a difficult challenge, because EPA has to go back to the community and acknowledge that it did not initially consider VI. Calling 20-year-old technology "new" does not sound "new" to the community, and can cause a credibility gap. Moreover, the regulator is behind the curve, because the community is more aware of the problem than he or she is. The agency representative is learning as he or she goes, so it can be difficult to address all the community's questions. Adding VI to an old investigation can cause mistrust and result in more work for the agency. New findings that the boundaries of a site are larger than initially addressed may cause new people to be brought into the site investigation and slow redevelopment efforts.

Explaining VI to community members is also a challenge, Mr. Polish said. Contaminated water, air and soil are easy concepts to explain, unlike unseen and odorless vapors coming from the ground. People often do not understand how outdoor pollution can affect their homes. In addition, the agency representative will have to get into a person's home, which is very sensitive. Mr. Polish sees his job as making everyone in the community aware; therefore, he said, everyone needs to be visited by the agency. This is not just leaving a fact sheet, but sitting down with the residents and explaining the situation. Mr. Polish advised meeting with the residents and community as soon and as often as possible, providing as much information as often as one can, making a connection, explaining the situation in common terms, and sharing the data.

Another challenge is sampling, which involves putting things in people's homes, interrupting their schedules, and dealing with their personal space. Zeroing out household contributors when sampling is another challenge. It is important to get all those items out of the home, so it is necessary to also provide a space in which people can store things like snow blowers or hobby materials. People are not aware that these things can cause measured levels to spike over the action level.

A participant asked what Mr. Polish would do when the resident is wrong about contamination on his property. Mr. Polish noted that for the site he had discussed, a community member said that affected residents would get a buyout and be able to move to Florida; however, not all community members were affected. EPA used the TAGA bus on all the houses to show that people were not being exposed; however, the residents wanted EPA to find contamination due to the promise of relocation. Mr. Polish noted that one person even poured gasoline into the sump in his home, but TAGA allowed EPA to show that this was new gasoline, not gasoline from the spill. Mr. Polish said that there will always be some people who will not be convinced, and advised "firehosing" the community with information; when the rest of the community understands, those people will eventually be silenced.

Case Study: Risk Management and Risk Perception in a Superfund Community

Kristine Matzko, a Remedial Project Manager (RPM), EPA Region 3, Philadelphia, PA, reported on a case in which an elementary school was planned to be built on a site across the street from a Superfund site. The groundwater plume from the Superfund site was under part of the property purchased by the school district, and a portion of the property had historically been used as a city dump.

The Superfund site had groundwater contamination; a pump and treat system was in place, and had been operating for 14 years. One groundwater well on the school property showed 1000 ppb total VOCs, mostly TCE and DCE. There was a high concentration of contaminants near the school district's property that was not being remediated by the wells that were treating the groundwater.

The school district installed and tested shallow groundwater wells, and examined soil and soil gas samples (their consultant indicated there was no VI risk). Nevertheless, Ms. Matzko reported, the district committed to building a vapor mitigation system as a conservative measure.

The district consulted with EPA and the Pennsylvania DEP, and hired consultants on legal and environmental issues.

Among the community's concerns, Ms. Matzko said, was that this was the first time many of the residents became aware that there was a Superfund site in the community. They were concerned about VI; even though it is an emerging issue, they got up to speed quickly. Residents were concerned about the effectiveness of the planned VI mitigation system and had a very conservative threshold for safety. Residents also asked: who should they trust? In responding to the issue, the community asked intelligent questions, developed awareness of VI as a pathway, was media-savvy in establishing connections to the media, attended school board meetings, and mounted a strong, quick response.

Summing up the stakeholder perspectives, Ms. Matzko said that the community wanted a very safe school and also wanted a reliable source of information. The school district followed the procedures necessary for it as a property owner. EPA served in a consulting role, not as an advocate, and tried to stay as neutral as possible, wanting the school district and the community to make the best decision for themselves. The Company operating the Superfund site was focused on cleanup, not reuse.

Ms. Matzko asked the audience: Would you send your child to this elementary school? She noted that millions of dollars were spent on purchasing the land and conducting studies; a state-of-the-art school design and environmental controls were proposed; but the property was still contaminated by groundwater from the plume from the neighboring Superfund site. She then reported that the school board decided not to approve the construction of the elementary school.

Some of the challenges Ms. Matzko faced as an RPM were distilling and relaying the issues in media interviews, making an evaluation of VI for a building that did not yet exist, being unaware of the community response until the time when the school board was preparing to vote on the construction, and maintaining a neutral role. Although people came to EPA to ask if the school would be safe, EPA was not a decision-maker, and thought it was critical that it be a community decision whether it be built.

Mr. Siegel commented that he had communicated with some parents and press at this site. The contamination was in the deep aquifer, but the shallow aquifer was fine; however, the concept of relative contamination in various aquifers was difficult to understand for the parents.

Risk Assessment Session (Michele Conlon, Moderator)

Risk Assessment Considerations

Dawn Ioven, a toxicologist in EPA Region 3, Philadelphia, PA, said that there is no single right approach for doing VI risk assessment. She focused more on the quantitative aspects, that is, the risk associated with a given concentration, but said it can also be correct to do a qualitative risk assessment, to determine the action associated with a certain level.

A baseline risk assessment is performed under a "no-action" assumption, Ms. Ioven said, that is, it asks whether there is a risk associated with the site "as-is." This assessment helps to justify what action is being taken. Risk assessments must consider current and future land use. For VI, they almost always consider residential and occupational exposures. Common exposure pathways are subsurface soil, groundwater, and air for VI, and inhalation is the focus in terms of exposure routes (ingestion and dermal contact are not an issue).

When assessing VI risks, Ms. Ioven said, one must choose whether to use modeling or empirical data. The Johnson & Ettinger (J&E) model is most commonly used. This model predicts indoor air concentrations based on subsurface or groundwater measurements. EPA recommends the use of site-specific model input parameters over generic numbers. The J&E model was developed to assist regulators in determining where data should be collected. The model is one line of evidence, Ms. Ioven noted, and empirical data are desired to support its conclusions. The J&E model cannot be used where site conditions do not meet the model's assumptions (e.g., if there is fractured bedrock, utility lines, or a shallow water table), so it is important for the risk assessor to work with the site hydrogeologist to determine the model's applicability.

Empirical data provide multiple lines of evidence. Groundwater data collected at the top of the water table show the concentrations available for vapor partitioning. Sub-slab soil gas samples are desirable, Ms. Ioven said, because then one does not have to worry about background. She noted that attenuation factors can vary greatly. Indoor air samples provide the truest measure of exposure, but it is necessary that background sources be completely eliminated. Outdoor air samples taken at the same time as other sampling allow the assessor to determine whether there is a background contribution.

EPA is mandated to consider both current and future land use in a baseline risk assessment. One difficulty is that assessors are often looking at sites with no structures, and VI is highly dependent on building structure. Ms. Ioven said that the best way to address the future scenario is to include language in the decision document that calls for mitigation measures during construction or for sampling (a more expensive option).

Ms. Ioven offered some "rules of thumb" regarding risk assessment. She said that a VI threat should be considered when: structures are within 100 ft laterally or vertically of a subsurface VOC source and when groundwater VOC concentrations are greater than MCLs. When a sub-slab soil gas concentration is more than 1000 times the target indoor air level, the probability of unacceptable vapor intrusion is likely sufficient to warrant proactive mitigation without further investigation. However, she said, she has seen situations where these parameters do not apply, so she urged caution in their use. Ms. Ioven said that risk assessors should use multiple lines of evidence, prefer empirical data, and consider future land use.

Risk Assessment Guidance for Superfund: Part F – An Overview

Michael Sivak, leader of the Superfund Technical Support Team, EPA Region 2, New York, NY, reported that Part F of the Risk Assessment Guidance for Superfund (RAGS) should be released within a few weeks of the Forum. Its purpose is to update the methodologies so that the Superfund risk assessment process is consistent with the processes used by other program offices that evaluate exposure to inhalation sources. Historically, the RAGS dates back to 1994. A

workshop on revising the RAGS methodology was held in 2003, and the work group has been very active since 2005. The workgroup has one member from each Region; many program offices are also represented. Its consensus review is complete and release of the document is pending.

RAGS Part F endorses the use of reference concentration (RfC) and inhalation unit risk, Mr. Sivak said. The previous approach used inhalation rate and body weight to calculate intake. The updated approach removes these factors; they are incorporated in the toxicology portion, rather than in the exposure assessment part. An exposure concentration is calculated and compared to the unit risk for cancer and the reference dose for non-cancer. Both cancer risk and non-cancer hazard are calculated. Several exposure scenarios can be used, e.g., residential (assumes 24 hours/day exposure), occupational (8 hours/day), and intermittent or trespasser (which assumes acute exposure). The new approach can be incorporated into RAGS Part D, which already includes columns for inhalation concentration and unit risk.

Mr. Sivak said that RAGS Part F also provides inhalation screening levels. It includes equations for calculating target contaminant concentrations in air. It also discusses target concentrations in other media, with a method to back-calculate from indoor air to soil, tap water, groundwater, etc. Inhalation risk assessment for children is by the application of age-dependent adjustment factors. The RfC is calculated to be applicable at any point in the lifetime, and risk assessors can identify site-specific subpopulation sensitivities. RAGS Part F also discourages route-to-route exposure extrapolation using default parameters, and recommends pursuing an alternative through PBPK or an other approach. When no alternate value is available, RAGS Part F recommends performing a qualitative risk assessment.

Case Study – Chemical Metals Industries

Jim Carroll, the Program Administrator of the Land Restoration Program, Maryland Department of the Environment (MDEP), Baltimore, MD, discussed a case in the Baltimore area. In 1981, the first removal action in the United States took place at the site. From 1997 to the present, post-removal investigations have been conducted, including soil, groundwater, VI, and soil removal. MDEP constructed a building on the site; since there is still a groundwater plume, a ventilation system was added. There are approximately 20 row houses nearby, and MDEP was able to obtain site access from some of the property owners. Indoor air testing in one house exceeded the risk threshold. Natural gas from a leaking line was also detected and addressed.

In one of the houses tested, 350,000 $\mu g/m^3$ of PCE was measured in an earthen basement; no one was living there, Mr. Carroll said. Levels on the first floor also exceeded the threshold. While MDEP has attempted to collect additional indoor air samples, the house is owned by an absentee landlord, and the only line of contact to that person has been disconnected. In another house tested, the data suggested a risk. Here, MDEP was successful in working with the landlord, and is developing a remedial approach. In the other houses tested, the indoor air levels were below the threshold.

Mr. Carroll said that MDEP believes there are two plumes, and that the houses are showing VI from a halo effect. MDEP is working on a remediation approach for soil and groundwater. In

two houses, PCE and TCE were measured sub-slab, but indoor levels were not above the $1x10^{-5}$ risk level, so MDEP is only monitoring those houses.

Mr. Carroll said that MDEP spent two years trying to track down the property owners. There were frequent changes in property ownership. When MDEP saw a house up for auction, they contacted the auction company to relay word to the owner that the owner needed to provide the information about contaminant levels, which MDEP had given him. Landlord-tenant issues contributed to delays in getting access to the houses to collect data; one landlord even suggested to MDEP that they come while he was at the house to evict a tenant. Mr. Carroll noted that the residents are faced with many unfortunate circumstances in these "houses of last resort," and VI is one more thing they do not need to worry about.

MDEP faced design challenges for VI mitigation systems in these 1920s row houses with stacked stone foundations, dirt or broken concrete floors, and inadequate electrical supply, Mr. Carroll said. MDEP developed solutions, but those will require additional visits to verify that they are working. Basements are used for storage in many of the homes; in one, however, a teenager lives in the basement. Logistically, MDEP had to help residents box up all their possessions, find a secure place to store them during construction, and then return the possessions after mitigation systems were installed.

Mr. Carroll said that in urban areas, site access, exposure issues, and "implementability" are key VI issues that must be addressed before getting to the risk assessment stage.

EPA OSWER Application of TCE Toxicity Data in Risk Assessment

Jayne Michaud, an environmental health scientist in EPA's OSWER, Washington, DC, said that OSWER's guidance includes a section on VI pathway analysis. For interim use, until the IRIS reassessment is complete, OSWER is using these toxicity values. They will supersede the toxicity guidelines in EPA's draft VI guidance, Ms. Michaud noted.

TCE is very prevalent at hazardous waste sites, Ms. Michaud said; however, the EPA reassessment of TCE toxicity will not be completed for several years. There is currently a need for consistency across the regions in how to assess TCE risk. Under current EPA practices, an MCL of 5 ppb is risk management standard for drinking water. The guidance will not affect groundwater. OSWER considers the IRIS database values to be the "gold standard." In their absence, OSWER works with ORD to develop peer-reviewed provisional toxicity values, Tier 2 values. Tier 3 is for peer-reviewed, publicly-available values, preferably from a regulatory agency. Evaluation of Tier 3 sources led to the adoption of California EPA's (Cal/EPA) inhalation unit risk value and oral cancer slope factor for risk assessment for cancer.

The preliminary cancer-based remediation goal for air is 1 $\mu g /m^3$ in indoor air. For drinking water, EPA will continue to use the MCL of 5 $\mu g/L$. Because other contaminants and/or pathways are present, assessments should be done on a site-specific basis. For non-cancer endpoints, the NY Department of Health air criterion and the Cal/EPA chronic reference exposure level are used.

Ms. Michaud offered these recommendations for VI risk assessment: use multiple lines of evidence, which may include site history and geology, ground water, soil gas, sub-slab soil gas, crawlspace data, indoor air, outdoor air, tracer compounds, chemical ratios, etc.; indoor air samples are useful where other data suggest a potential VI problem; it may be more expeditious to collect indoor air data in parallel with soil gas and ground water data; and it may be more efficient to mitigate before new construction begins.

Case Study: Vapor Intrusion Risk Management – Bally Ground Water Superfund Site

Mitch Cron, a Remedial Project Manager (RPM), EPA Region 3, Philadelphia, PA, described the Bally Case and Cooler site in Pennsylvania. Bally progressed from manufacturing wooden cabinets and cedar chests to insulated display cases, which initially contained fiberglass and then urethane foam. When the company switched completely to urethane foam, TCE was used as the degreasing solvent. Bally eventually began to make walk-in freezers. The company closed in 1995.

Mr. Cron said that there were solvent releases from the early 1960s to 1969, when the manufacture of meat display cases and walk-in freezers ended. The probable sources of TCE were a 2,000-gallon dip tank (used for the interior boxes of freezers), and four shallow wastewater lagoons, sites of evaporation and volatilization. A review of historical aerial photographs showed that the lagoons that existed in 1955 were closed and built over by 1965. New waste lagoons were dug in another portion of the site. By 1975, both lagoon sites were under buildings. When Bally ceased operations in 1995, the property sold and divided into multiuse properties. Today, the facility is still essentially the same in terms of the buildings on the site.

A plume of groundwater contamination emanates from the site through a large portion of the valley. The most contaminated portion is between the site and the municipal well, which provides the town water supply. That water is subject to air-stripping treatment. This portion of the groundwater plume shows about 100 ppb total VOCs, with 10 ppb total VOCs in the larger plume. Soil contamination is suspected at the facility. In 2000, a developer constructed townhomes just to the east and immediately adjacent to the site; the townhomes overlay the most contaminated portion of the plume.

EPA looked at the locations of the1955 lagoons, 1965 lagoons, dip tank and townhomes for VI, Mr. Cron reported. Sub-slab and indoor air samples were taken on the site, and sub-slab samples at the town homes. The 1955 lagoons showed profound contamination, in millions of ppb. The concentrations were much lower in the 1965 lagoons. The dip tank concentrations were reasonably high. The vast majority of samples taken from townhomes were $<1\ \mu g/m^3$. The indoor air results for the building built above the 1955 lagoons (the most contaminated part of the site) indicated an unhealthful level of exposure for workers inside the building. Mr. Cron said that EPA concluded a removal action was warranted. The building built over the 1965 lagoons had much lower concentrations, and no further action seemed to be warranted. At the location of the dip tank, sub-slab concentrations were high, but indoor air concentrations were not. EPA concluded that mitigation was not warranted, but that monitoring was appropriate. Sampling at the townhomes showed only very low sub-slab concentrations of TCE in 4 of 133

samples. EPA did not feel further action was warranted given the low concentrations and attenuation into indoor air.

In summation, Mr. Cron said that sub-slab sampling was "high value" in this case, because it showed EPA where to take action. Historical evaluation of the site using aerial photos was useful and contributed to the multiple lines of evidence. The outcome at this site was not a foregone conclusion. While EPA expected a problem in the area of the1965 lagoons, they were pleasantly surprised when no such problem was found.

Q&A and Discussion on Risk Assessment

A participant asked for clarification of a statement in Ms. Ioven's presentation, saying that she had quoted ITRC as saying that sub-slab soil gas results greater than 1000x indoor air levels were indicative of a VI problem. The participant said that the statement was taken out of context and that ITRC said that if the results are more than 1000x higher than indoor air screening, there is probably a VI problem, and one would want to move directly to mitigation.

Regarding the townhomes in the Bally site, a participant asked whether there was any concern that over time vapors could concentrate under the slabs. Mr. Cron said that because the plume had been present for a long time, there had been sufficient time for the sub-slab concentrations to reach a steady state. There were 3-4 samples taken at each structure, and the concentrations were so low as to not be of further concern.

A participant asked, with regard to future VI guidance, for a recommendation for representative exposure point concentrations when multiple samples are requested throughout a house. Mr. Sivak expressed a preference for collecting samples from the basement and the first floor living space, saying that these give more information to characterize the profile and tell how vapors may be migrating. If only one sample could be taken, he said, he would probably bias it toward the area where he expected there would be a problem. Ms. Ioven noted that toxicologists generally ask for sub-slab, indoor air, and outdoor air samples, but if just one were to be taken, she would prefer that it be of the location where the highest level was expected.

A participant asked Ms. Michaud whether the point of departure of 1 $\mu g /m^3$ addressed non-cancer endpoints. Ms. Michaud said that the practice is to protect both cancer and non-cancer effects, and the point of departure is consistent with 10^{-6} risk.

Mr. Steve Glaser said that it did not seem that the J&E model addressed weaknesses with indoor air monitoring, e.g., a single sample from one point in time. Ms. Ioven said that indoor air is a snapshot; models are applicable in certain instances and those who use them should know those instances, as well as the model assumptions. Mr. Sivak said that there are several ways to evaluate potential risks from indoor air, and the quantitative approach is one. Multiple lines of evidence are used for risk estimation and decision making, he said, and the J&E model is one tool. However, no single tool should be used to make a decision. Ms. Ioven said that sub-slab measurements are favored because they tend to be less vulnerable to fluctuation than indoor air measurements. Just because the indoor air level is low on sampling day, does not mean that one should walk away if there is a significant sub-slab issue.

Mr. Siegel said that the action level used in Mountain View is 1 μg /m^3. Outdoor air levels are 0.2 to 0.5 μg /m^3, and one cannot mitigate below the outdoor air level. He also said that if EPA takes into account cumulative exposures and sensitive populations in the risk assessment, one should not get hung up on the exact numbers, but should focus on mitigation.

Engineering and Site Development Session (Michael Gill, Moderator)

The ASTM Standard and Legal Issues Associated with the Development of Property with Potential Vapor Intrusion

Larry Schnapf, an attorney with the firm Schulte, Roth & Zabel, New York, NY, noted that there is confusion in the real estate industry regarding when VI should be addressed. There is currently a separate ASTM standard on VI, he said. There is a feeling among some parties that the standard should be withdrawn and a practice guide be issued. Once the ASTM standard was published, litigation began to be filed. He reviewed some notable VI litigation, noting that the pace of filings is accelerating. Mr. Schnapf wondered whether VI will be as persistent legally as asbestos and mold have been.

Off-site migration of contaminants is driving decisions about listing and reopening sites, and is the leading cause of litigation. Homeowners in those cases argue that they are exposed to vapors from an industrial location. In the case *Sher vs. Raytheon*, the Florida DEP did not require remediation of the site, and the local town allowed the use of groundwater for irrigation. Those wells are now posing the potential of exposure to residents, and a class action lawsuit has been filed.

VI can also be an issue in lease liability cases. Mr. Schnapf described a New York landlord-tenant case, involving a site with a history of dry cleaning. The site subsequently was developed as a school, and then was sold to be developed for self-storage. The issue was exposure to pregnant women and children visiting the self-storage units. The landlord claimed it was the tenant's issue, but basic real estate principles kept the landlord involved.

Case Study: Vapor Intrusion Mitigation Measures at the Former Bethlehem Steel Plant

Dr. William K. Ahlert, Vice President, HDR Engineering, Inc., Allentown, PA, said that the Bethlehem Steel site was over 100 years old, and had operated from the late 1800s through late 1990s. Lehigh Valley Industrial Partners acquired 1,000 acres of the site in May 2004; plans were to redevelop the acreage into mixed manufacturing, high-tech, and office space.

One area of the site, Slag Bank 3, covered 47 acres. There was up to 40 feet of fill, including slag, coking residuals, and other debris. Scrap metal sorting and storage had been conducted there, and unlined surface impoundments operated there from 1950 until they were closed by filling with slag in 1978.

Mr. Ahlert said that before its bankruptcy, Bethlehem Steel recognized that EPA and the Pennsylvania DEP would need to be involved in the site. They formed a work team that is still in

place after 15 years. The team members bring a great deal of knowledge, allowing issues to be addressed with less time spent bringing people up to speed historically.

Mr. Ahlert's firm does systematic site characterization. First, they do a passive soil gas test to get an idea of where VOCs are found and how to move forward with other techniques. Then they use active soil gas sampling to try to quantify the contaminants. Finally, they conduct trenching, which allows full visual characterization as deeply as possible. At this site, passive soil gas sampling revealed VOCs. Active soil gas SUMMA sampling showed naphthalene, which was part of coking operations at the site. Sampling was done to allow horizontal and vertical characterization, e.g., to assess whether contamination is deep or shallow, so that Mr. Ahlert's firm could advise the buyer in the development and use of engineering controls.

Mr. Ahlert said that 93 soil samples were collected from the linear test trenches; a full analysis was run on all of the samples. Several compounds in soil were above the Pennsylvania DEP MSC levels, namely, BTEX, PAHs, and metals. Benzene, naphthalene, and TMB were well above the Pennsylvania DEP MSC for soil gas.

In a soil gas risk analysis, Mr. Ahlert's firm used the J&E model to predict concentrations that might occur with various uses of the property. He said that they were not surprised that the levels exceeded the applicable HQ/IR in the southern portion of the site. They then considered what mitigation approaches could be used. The clean-up approach devised included a soil management plan, onsite reuse of slag (which is good for construction), and pathway elimination through engineering controls. Specific components are a vapor mitigation system, capping to reduce infiltration, an indicator barrier, and deed restrictions. The vapor mitigation system has a vapor barrier membrane with a geotextile cushion, and a vapor collection layer (composed of aggregate and PVC pipe with a vent pipe). Mr. Ahlert's firm chose sub-slab depressurization with powered exhaust fans, ruling out a passive system.

Some of the design considerations relevant to the site include building size, fan selection, placing fan discharge at least 12 inches above the roofline, pitched pipelines to address condensation, and elevated fans. Systems will include alarms and pressure gauges to determine that there is always a pressure gradient. Quality control measures will be used to determine joints, seams, and perforations are sealed. There will also be confirmation sampling, either negative pressure confirmation or IAQ monitoring. Mr. Ahlert said that starting the process at the beginning of construction made these measures "not that expensive." He suggested that it may be better to simply address VI issues during construction, rather than go through an extensive cost-benefit analysis.

Mitigation and Control of Vapor Intrusion

Ron Mosley, an environmental scientist, EPA ORD, Research Triangle Park, NC, said that indoor VI contamination problems require sources, entry paths, and driving forces to cause entry. Mitigation is a temporary solution until someone cleans up the source, and any method that eliminates one of the three factors is a good one.

VI can even occur in mobile homes, if the home has tight skirting, Mr. Mosley said. In houses, contaminants can enter concrete block stem walls, travel into interior walls, and exit through

switches and nail holes. The expansion joint between the slab and stem wall, used as a water control, is also an entry point. Plumbing penetrations also allow gases into houses.

Mr. Mosley commented that residential construction is often not as high quality as commercial construction. In older buildings, plumbing access holes are very large. They are usually just covered, not sealed, and present significant potential leaks. In houses, sumps are also often not well-fitted.

People think a house is like a giant vacuum cleaner that sucks gases from the soil. Actually, differential pressure drives contaminant concentration (based on radon data). In selecting mitigation technologies, one can either choose a technology that prevents entry or one that removes contaminants after entry. In the first category are approaches like sealing, or removing the driving forces by depressurization or pressurization. Technologies for removal include ventilation, adsorption, catalytic/photo-catalytic oxidation, and scrubbers, although none of the last three is well established in the field.

New Developments in Vapor Intrusion Control

David Folkes, PE, the President of EnviroGroup Limited, Centennial, CO, said that not much can be done to improve on the active sub-slab depressurization systems that were developed for radon. The desire to have passive systems is driving new developments. While passive systems do not work as well as active systems, people want to use them.

If a building has a dirt floor, gas enters at a rate controlled largely by diffusion through the soil, Mr. Folkes noted. One often finds advective forces near buildings, but the amount of contaminant coming into buildings is controlled by diffusion. If a building has a slab, the slab is a barrier that restricts gas entry. As the concentration below the slab increases, soil vapor flux decreases, so less contaminant is coming up. Soil gas moves laterally to cracks, making the pathway longer for the contaminant to get into the building. Because the area under the slab is a part of the plume, concentrations naturally vary under the slab, meaning that alpha (the attenuation factor) is going to vary. One should not expect the attenuation factor to be constant.

If there is gravel under the slab, the permeable base course may increase soil vapor flux. Mr. Folkes said that gravel essentially removes the effect of the slab as a barrier by introducing a permeable layer. It becomes easier, with advection, for the building to sweep in gas, and the diffusion gradient steepens again. Regardless of what is occurring in the sub-slab area, more gas will be getting into the house. If the base course is used to vent gas from the sub-slab region, or to reverse airflow, this amounts to sending the contaminants somewhere else.

Mr. Folkes said that it is important to understand how the subsurface will respond to mitigation. To do mitigation well, one must understand the differences among barriers (that stop), venting (that dilutes), and depressurization. Barriers are passive mitigation, he pointed out. They must have integrity and be robust. If just barrier is used, it is better to not have a permeable area beneath it. Two nonpermeable layers, e.g., a slab on clay, will be more effective. Mr. Folkes called Liquid Boot®, a thick asphaltic spray-on, the "gold standard." He also mentioned Geo-Seal™, which includes a high-density polyethylene (HDPE) layer and spray-on asphalt. The HDPE is thick and inflexible, but the combination allows the barrier to be kept thin.

In the area of venting, aerated floor systems are new to the United States, Mr. Folkes said. These allow highly efficient movement of air through voids in the slab (e.g., Cupolex®). The Windi® system can be placed on existing floors. The driving force for venting air is usually thermal gradients in a passive system. Geosynthetic media (geogrids and geotextiles) are placed below a liner and act as more efficient collection systems.

In terms of sustainable mitigation, Mr. Folkes predicted more emphasis in the future on reduced energy requirements, such as use of wind turbines or solar power, or intermittent fan operation that is tied to building operation, monitoring, or occupancy.

Case Study: The Mott Haven Campus in the Bronx: Long-term Site Management

Al Rodriguez, Counsel to the Bronx Borough President, Bronx, NY, began his presentation by noting that many city school districts are severely overcrowded and looking for land on which to build new facilities. The situation in New York City is so desperate that Brownfields are being considered. In 2001, the school system was looking for a site in the Bronx for a campus to accommodate new high schools. They found an old rail site, which had been used back to the 1890s. Mr. Rodriguez said that the site had been used as a railyard, with all the normal uses expected; currently, MetroNorth trains run directly past the site. There was a manufactured gas plant directly adjacent to the site, as well as nearby gas stations, auto repair shops, and laundries.

A number of contaminants were found in both soil and water. After the initial investigation, the school construction authority (SCA) proposed a remedial plan, which included evacuating soil and refilling the site with clean ground fill, and engineering controls including sub-slab depressurization, and a hydraulic barrier around one edge to keep contamination from coming off the site. The community was not informed of these decisions, Mr. Rodriguez said. In 2004, the mayor announced that a 4-school, 2000-student facility was going to be developed on the site. The community had still not been consulted, and few people became involved.

When the city entered the site into the State Brownfields program, public hearings were required. A community organizer attended the hearings and started calling members of the community. Mr. Rodriguez said that persons in schools around the site had experienced problems, including rashes and cancers, for years. The community organizer connected this information with what had come to light about the site and contacted a councilperson, who took an active interest in the project. The councilperson helped the community access resources to understand the issues, and have some say in remediation and long-term management.

The city required the SCA to provide community groups with funds to hire consultants in order to get independent input on the site, the remediation plan, and future steps, and also to comment on the consultants' recommendations. Mr. Rodriguez said that the most important of these recommendations was for a robust, long-term site management plan (SMP). This was first mentioned in January 2007. The SCA produced an outline of a long-term SMP that listed topics to be addressed, but no content. The community's attorneys were concerned, and filed suit, noting that the law required the SCA to have the long-term SMP in place at the time the remedial action plan (RAP) was approved.

When Mr. Rodriguez started working for the Borough President in July 2007, he became involved in the school issue and organized the President's office. In concert with the community groups, lawyers, Mr. Siegel, and others, the office stressed the need for the SMP to be produced. While these efforts were going on, some other events were noted: a school in Queens was built on a Brownfields site with engineering controls, but without the community's knowledge, and Mr. Rodriguez's daughter's school was evacuated due to construction activities on a Brownfields site across the street.

Eventually, the parties relented, Mr. Rodriguez said, and agreed to produce a long-term SMP in order to provide sufficient structure to assure the community that activities would be monitored over the long term. The SCA lost the law suit; the court found that if the SCA produced a RAP that required an SMP, then the SMP had to be produced at the same time as the RAP. Mr. Rodriguez concluded by noting that in urban areas, projects can not be rushed, without doing the homework on long-term SMPs.

Q&A and Discussion on Engineering and Site Development

A participant asked about the most common groundwater intrusion systems. Mr. Mosley said the most common was to collect water in the sump and pump it out. The participant noted that since the water is still entering the home, it can pose a VI problem. Mr. Mosley said that it is important to keep contaminated water from seeping down walls, from which exposure can occur. Mr. Folkes said that aerated floor systems can be put on the wall, and will drain and ventilate the interstitial area. Mr. Mosley said that new sealant products can be applied to seal the inside of the wall, but water will still need to be drained to a sump or to the outside.

A participant commented that school safety has not been discussed in a policy context, and expressed the hope that those working on VI at EPA might collaborate in the Agency's development of guidance on school siting to ensure that VI is a part of it.

Another participant noted that PCE and TCE were the drivers in VI cases, and asked if anyone had seen vinyl chloride, and if so, how it would be mitigated. Mr. Folkes said that he had seen it at some sites, and recommended an active mitigation system.

A participant inquired whether mercury had been sampled in indoor air at the Bethlehem Steel site. Mr. Ahlert responded that it was only found in areas related to the salvaging operation on the site, and that the concentrations were not an issue, when compared to the Pennsylvania screening criteria.

A participant asked Mr. Rodriguez about the costs of site preparation and implementation of the long-term plan at the Bronx school site. Mr. Rodriguez said that it was set up to have school employees do most of the monitoring. Mr. Siegel said that additional site management costs were marginal. He noted that for schools, there is generally a lot of thought put into mitigation, but protocols are needed for long-term management.

Closing Remarks

Mr. Schuver thanked the attendees and noted that it was clear there was a great deal of good work underway and that things are happening, e.g., thousands of people are not being exposed via VI due to that work. He noted that the efficiency of decision-making could be improved by providing a clear and formal opportunity for meaningful public involvement in the risk decision-making process. The people potentially exposed to VI have a unique standing and should be heard.

Mr. Boyer said that the catchphrase for VI was "education, education, education." It needs to start with case managers and project managers who should know what they are doing with investigation and remediation. VI is a new pathway with a steep learning curve for both consultants and regulators, he said. Education extends to the communities as well. It was important for the Forum to hear community stakeholders' perspectives. Regulators have an obligation to educate the people whose houses they are entering because of VI. The Forum provided education for the attendees, who will take this knowledge back and disseminate it. Because VI is a growing issue, Mr. Boyer urged attendees to keep the level of knowledge high and to provide training opportunities, such as ITRC is doing in April in Oklahoma.

Mr. Siegel said that the term "intrusion" is a good one from the public's point of view, because VI is pollution that comes uninvited into one's home, affecting health, children, and property values. He noted that people are reacting to the intrusion, not just to the science. The regulatory system is structured to deal with VI through hazardous waste cleanup, and community members do not understand that regulators can not address VI from other sources, e.g., dry cleaning. As a regulator, it is important to help the public learn who can deal with that aspect of VI, including legislators and producers of consumer products. In general, Mr. Siegel said, people want to limit the contamination, not the specific pathway. He urged participants to consider developing comprehensive site models that address all the sources and pathways.

The Philadelphia skyline from the Forum's hotel, Loew's.

Final Word

Bill Hagel and Mike Gill wish to thank everyone who played a role in making this event a success: the planning committee, our sponsors, attendees, logistical support and definitely our speakers. Here are some pictures from the event.

Left: The opening slide showing our EPA sponsors: ORD's Office of Science Policy, OSWER, the Land Research Program, and OSRTI. Right: Bill Hagel opening up the National Forum on Vapor Intrusion.

Left: Planners Bill Hagel and Mike Gill, surrounding ORD colleague Steve Mangion.
Right: Mike and Bill, with sponsor Michele Conlon from ORD's NERL Lab.

Left: Community stakeholders Peter Strauss and Lenny Siegel, with EPA's Michele Conlon, Bill Hagel, Mike Gill and Henry Schuver. Right: The attractive Philadelphia skyline at night.

APPENDIX I: STAKEHOLDERS BREAKOUT SESSION – MODERATOR'S SUMMARY

The viewpoint and opinions expressed in this summary are solely those of the author and do not necessarily reflect the position or opinion of the US Environmental Protection Agency.

STAKEHOLDERS SPEAK UP
A Summary of Community Views at the National Forum on Vapor Intrusion

Philadelphia, Pennsylvania—January, 2009

By Lenny Siegel
Center for Public Environmental Oversight
February, 2009

The National Forum on Vapor Intrusion, sponsored by U.S. EPA in Philadelphia January 12-13, 2009, brought together the largest group yet of vapor intrusion public stakeholders from across the country, along with a few hundred regulators, consultants, and others. Fourteen of those stakeholders described in varying detail their experiences with vapor intrusion investigation and response. Some of the stakeholders have years of experience with vapor intrusion, while others have only been familiar with the issue for a few months.

The most striking common theme was that the stakeholders at the forum are frustrated with the rate of progress at their sites. Even where they have good relations with regulators and other officials, they pointed out shortcomings in their response programs. Perhaps this is partly a function of self-selection. People completely satisfied might be less interested in attending such a forum. Nevertheless it's important that government people recognize that their communities may give them lower grades than they give themselves.

Agency presentations at the forum explained that states and EPA regions do not have a uniform approach to vapor intrusion, and the stakeholders reacted with confusion. Some called for a uniform framework against which they could evaluate activities in their own communities. They recognized the need to adapt that framework in response to local input, but particularly in states with weak programs they want to be able to reference a final EPA Vapor Intrusion Guidance. Mary Moore, a stakeholder from Phoenix, Arizona, said her state still would not initiate a vapor intrusion investigation at the Superfund site in her community until EPA finalizes its guidance, and Barry Durand, a community member from Asheville, North Carolina wished that EPA and state officials at his site—none of whom attended the forum—would act as protectively as some of the regulators at the forum.

At a three sites, at least—North Carolina, Arizona, and Maryland/DC—stakeholders were perplexed by the relationship between state regulators and U.S. EPA. It seemed clear that EPA needs to clarify when and where it can exert authority over state agencies, both at sites on the National Priorities List and those that are not.

Stakeholders also expressed concern that there is no clear national action level for indoor air exposures to common contaminants PCE and TCE. Mike Schade, a New York City activist who lives above the Meeker Ave. PCE plume in Greenpoint, Brooklyn, noted that New York's standard for PCE exposure is much less protective than EPA's Regional Screening Level. EPA is working on an interim policy for TCE exposure, but that was announced near the end of the forum, after the stakeholder meeting, so there was no discussion of that policy.

Significantly, most of the stakeholders highlighted the impact of vapor intrusion investigations and mitigation on property values. As I've said before, the health impact of vapor intrusion is uncertain and in most cases manifests itself over many years. The impact on property values, however, is usually immediate and catastrophic. Contamination stigmatizes and drives down the value of property. Mike Barry, from the Modock Springs site in Victor, New York, reported that homes above the TCE plume there have seen sold substantially below their non-polluted value and that others were "not able to sell."

The activists who attended the forum advocated reductions in property tax assessments to reflect the reduced values. Debra Hall, from Hopewell Junction, New York, explained how the polluter at her site, Hopewell Precision, received a significant assessment reduction because of pollution that it caused, but that homeowners whose values were driven down by the water pollution and vapor intrusion barely received any adjustments. Mike Barry proposed more than assessment adjustment. He and his neighbors are pursuing a Property Value Protection Plan, in which the responsible party and government agencies would reimburse homeowners for lost equity due to site contamination. Their State Senator has pledged funds, but they are still negotiating with local officials and the responsible party at the site.

Several stakeholders also blamed the fear of declining property values for the refusal of many homeowners in their communities to cooperate with investigations by allowing subslab soil gas or indoor air testing. That is, if there is no evidence of vapor intrusion or mitigation (subslab depressurization system) in place, they figure potential buyers won't consider the property stigmatized. Carol Meschkow, from Long Island, said that some people in her town didn't want her even to talk about contamination because it might impact property values. Similarly, I received warning calls in Mountain View, California, where I live, when I first did news interviews about vapor intrusion several years ago.

Presenters did not understand why agencies are so reluctant to test indoor air. Jane Horton, also of Mountain View retold how her home was sampled only after the MEW Superfund Study Area plume boundary was redrawn—after remediation of the large regional plume was reportedly 75% complete, measure by mass reduction. She proposed:

> With all the variability in soils and preferential pathways, it should be mandated that indoor air testing happen for any inhabited building within several hundred feet of volatile organic contamination, and that the perimeter for testing expand outward until no contaminated indoor air is found.

Mike Schade and his landlord are trying to find a firm to independently test the air in his building.

Activist presenters expressed concern that regulatory agencies sometimes decide against installing mitigation such as sub-slab depressurization based upon too few samples. As Debra Hall illustrated with a table of TAGA (EPA's Trace Atmospheric Gas Analyzer) results taken a week apart in her home, indoor air samples can vary significantly over time and space. Mike Barry and his neighbors convinced his State Senator to fund mitigation for homes where the Department of Environmental Conservation would not. He insisted:

> While my soil vapor intrusion results indicate minimal exposure, my well is known to have the highest contamination of any private well and because no clean up plan has been

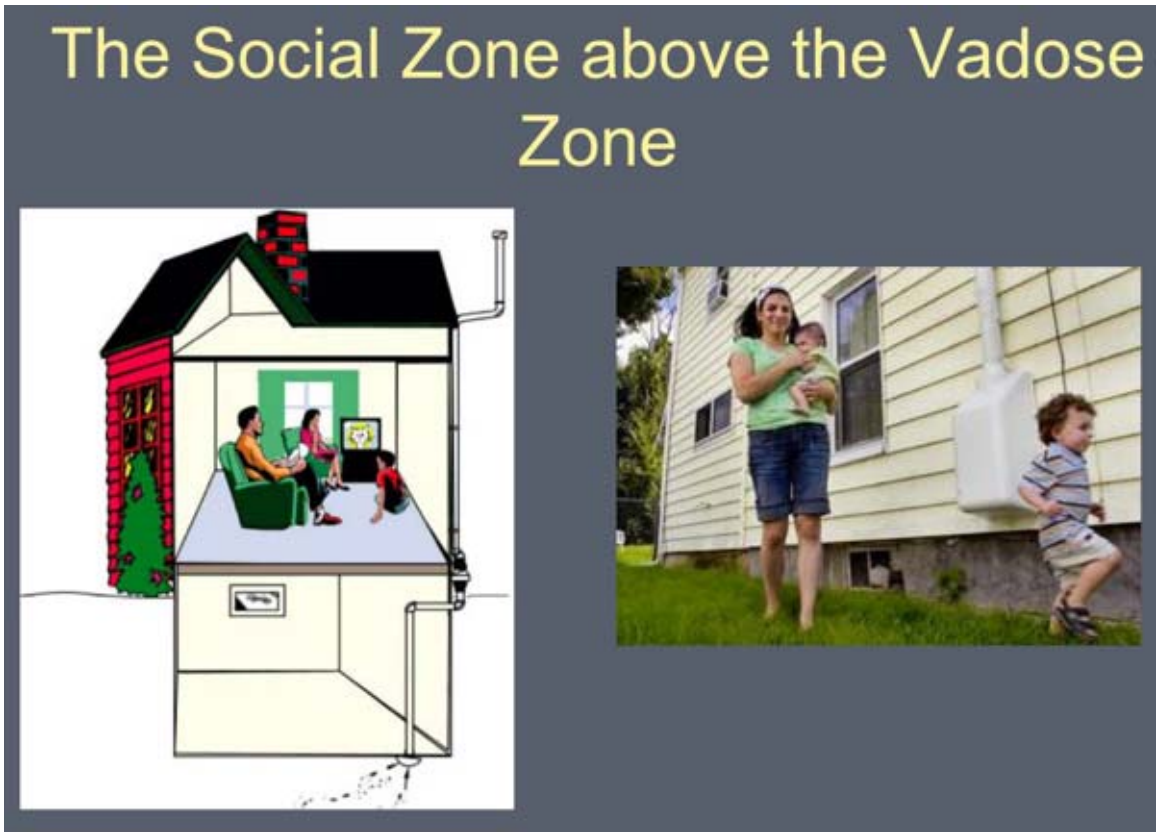
> published, I demand that a vapor mitigation system be installed at my house. I will no longer play Russian Roulette with my family's health.

Some presenters, such as Buddy Andrade from New Bedford, Massachusetts, described the impact of vapor intrusion (or its potential) on economic development, but more participants focused on health issues. From Mountain View to Asheville to Victor, community members have noticed what appear to be disproportionately high cancer and other disease rates, but health studies rarely provide any acknowledgement that people have been affected. Dawn Phillip of New York Lawyers for the Public Interest and Debra Hall both emphasized the risk of exposing children to TCE in their schools and athletic facilities.

At site such as Hopewell Junction, Asheville, and Victor, stakeholders expressed concerns that polluters are not being held fully accountable for cleanups. It appears to them that regulators are less likely to spend money on investigation, mitigation, and remediation where the funds come from taxpayer-funded accounts, rather than deep-pocketed responsible parties.

Like some of the other speakers at the Forum, public stakeholders called for source remediation, not just mitigation, as the solution to vapor intrusion. They recognize that reducing groundwater contamination to levels no longer posing a vapor intrusion risk may take decades, but they don't trust mitigation approaches to remain protective in the long run. Peter Strauss, who acts as a technical adviser to several community groups, explained how the Center for Public Environmental Oversight's (CPEO's) "Technology Tree" http://www.cpeo.org/tree.html provides user-friendly access to information about remediation technologies. Al Rodriguez, General Counsel in the Bronx, New York Borough President's office, described the under-construction Mott Haven schools campus, where the local community united to insist both on a robust cleanup plan and that long-term site management be part of that plan, to protect against and monitor vapor intrusion. Other presenters, such as Debra Hall, said that they want assurances that mitigation systems are indeed reducing indoor contamination to acceptable levels. Jane Horton suggested:

> If there is indoor air contamination found, sampling should be ongoing until the groundwater is cleaned up. If there is no contamination found, there is still the potential for new vapor intrusion pathways to happen. My belief is that testing for both detected and non-detected TCE contamination in the indoor air should take place every six months.



Since a number of audience members in Philadelphia were community involvement experts from EPA and other agencies, there was extensive discussion of the best ways to engage communities, both in the overall oversight of response activities and in gaining rights of entry to sample in and under homes. Endicott resident Peter Little, an Applied Anthropologist, described the importance of the "Social Zone above the Vadose Zone." He explained how understanding site history—in the Endicott case, deindustrialization—is often the key to community attitudes. Demographic factors, such as age, education, ethnicity, and immigration status all influence community response. For example, Polish immigrants in Greenpoint apparently do not feel comfortable cooperating with government agencies, so they have refused rights of entry. I suggested that community-based organizations could bridge the communications gap.

As described above, recognizing residents' health and property value concerns, issues that environmental regulators do not normally address, may be key to establishing trust. Dawn Phillip, Mary Moore, and Al Rodriguez all emphasized that communities need independent technical consultants. Jane Horton and Mary Moore discussed the importance of community advisory groups, but Moore reported that state officials have not convened the such meetings at her site for months. Some of the presenters reported that it has been useful to tailor public meetings to site conditions. Teddi Lopez said that block meetings, rather than larger area-wide meetings, proved successful at the Chillum site on the Maryland-DC border. Mike Barry said house meetings were valuable in Victor.

Overall, stakeholder presentations in Philadelphia reinforced the understanding that public participation, while necessary in all toxic cleanups, is particularly important at vapor

intrusion sites because regulators and consultants, like the vapors they are chasing, must intrude into people's homes. It is essential that those charged with leading investigations and responses consider the perspectives of occupants—residents, employees, and school families. When people learn that some company has released volatile compounds into the environment, and that those compounds may have polluted the air in their buildings and possibly their drinking water for years or even decades, they are unlikely to be satisfied with technical descriptions of vapor intrusion and the techniques for measuring it. They want their fears and concerns about health and property values acknowledged, and many—generally not represented at the forum—want to be assured that cooperating in the investigation will not make their personal financial and living situations worse.

APPENDIX II: FORUM AGENDA

Monday January 12		
7:30am	**Registration**	
Plenary Session		
9:00am	Welcome to Region 3	**Jim Burke**, Director, Hazardous Site Control Division, EPA Region 3, Philadelphia, PA
9:10am	EPA Perspective on Vapor Intrusion	**Henry Schuver**, Chair - Vapor Intrusion Workgroup, EPA OSWER, Washington DC
9:20am	Community Stakeholder Perspective on Vapor Intrusion	**Lenny Siegel**, Executive Director of the Center for Public Environmental Oversight, Mountain View, CA
9:30am	Vapor Intrusion Pathway: ITRC and States' Perspectives	**John Boyer**, Co-Chair, ITRC VI Team, New Jersey Department of Environmental Protection, Trenton, NJ
Community Case Studies, Lenny Siegel - Moderator		
9:40am	Vapor Intrusion and Social Science: The Case of TCE Contamination in Endicott, NY	**Peter Little,** Endicott, NY
10:00am	Breathing and Drinking VOC's in Hopewell Junction, New York	**Debra Hall,** Founder, Hopewell Junction Citizens for Clean Water, Hopewell Junction, NY
10:20am	**Break (15 Minutes)**	
10:35am	Lessons Learned from the Chillum TCE Site, Maryland	**Teddi Lopez**, Washington DC
10:55am	**Q&A and Discussion on Community Case Studies**	
Sampling and Assessment Session, Kathy Davies - Moderator		
11:15am	Understanding the Conceptual Site Model for Vapor Intrusion Into Buildings	**Dr. Lilian Abreu**, Civil/Environmental Engineer , Geosyntec Consultants, Santa Barbara, CA
11:35am	Ongoing and Planned Research at NRMRL-Ada on Gas and Vapor Intrusion	**Dr. Dominic Digiulio,** Environmental Engineer , EPA Office of Research and Development (ORD), Ada, OK
11:55am	**Case Study**: Sub-slab vs. Near-slab Soil Vapor Profiles at a Chlorinated Solvent Site	**Dr. Brian Schumacher**, Chief, Characterization and Monitoring Branch, EPA-NERL, Las Vegas, NV
12:15pm	**Lunch (on your own)**	
Sampling and Assessment Session (cont.)		
1:15pm	Using the TAGA Mobile Laboratory to Resolve Vapor Intrusion Issues; Interpretation of Multiple Lines of Evidence for Vapor Intrusion	**Dave Mickunas**, EPA Environmental Response Team, Research Triangle Park, NC
1:35pm	Empirical VI Database Background Indoor Air Review Updated J&E Spreadsheet Model Addendum	**Bill Wertz**, New York Department of Environmental Conservation, Albany, NY
1:55pm	**Q&A and Discussion on Sampling & Assessment**	
2:15pm	**Break (15 minutes)**	
2:30pm to 5:30pm	**Government Breakout Session**	**Community Stakeholder Breakout Session**
	Jack Kelly, Moderator	**Lenny Siegel, Moderator**
	SPEAKERS State of NJ Program: John Boyer State of NY Program: Bill Wertz State of PA Program: Jim Shaw State of DE Program: Rick Galloway State of VA Program: Gerald Grimes State of Maryland Program: Jim Carroll **State Panel Discussion** Role of Enforcement: James Miles, EPA OECA	**SPEAKERS** Peter Strauss, San Francisco, CA Mike Schade, Brooklyn, NY Dawn Philip, Brooklyn, NY Mike Barry, Victor, NY John "Buddy" Andrade, New Bedford, MA Mary Moore, Phoenix, AZ Jane Horton, Mountain View, CA Barry Durand, Weaverville, NC

	DoD: Richard Mach, Dept. of the Navy EPA Region 3: Jack Kelly EPA Region 2: Michael Sivak EPA Region 6: Sai Appaji **Federal Panel Discussion**	
6:00pm – 8:00pm	**Poster Session and Evening Reception** **Reception Champions:** **HydroGeoLogic, Inc.; CH2MHill;** **Sullivan International Group, Inc.; Pontarolo Engineering, Inc.**	
Tuesday January 13		
8:00am	Day 2 Welcome: Announcements	**Bill Hagel,** Superfund and Technology Liaison, EPA ORD/Region 3, Philadelphia, PA
8:05am	Government Breakout Session Report	**Jack Kelly**, On Science Coordinator, EPA Region 3, Philadelphia, PA
8:20am	Community Stakeholder Breakout Session Report	**Lenny Siegel**, Executive Director of the Center for Public Environmental Oversight, Mountain View, CA
8:35am	**Q&A and Discussion on Breakout Sessions**	
8:50am	Community Involvement Challenges at Vapor Intrusion Sites	**David Polish**, Community Involvement Coordinator, EPA Region 3, Philadelphia, PA
9:10am	**Case Study**: Risk Management and Risk Perception in a Superfund Community	**Kristine Matzko**, Remedial Project Manager, EPA Region 3, Philadelphia, PA
Risk Assessment Session, Michele Conlon - Moderator		
9:30am	Risk Assessment Considerations	**Dawn Ioven,** Toxicologist, EPA Region 3, Philadelphia, PA
9:50am	Risk Assessment Guidance for Superfund: Part F – An Overview	**Michael Sivak**, Leader, Superfund Technical Support Team, EPA Region 2, New York, NY
10:10am	**Break (15 Minutes)**	
10:25am	**Case Study**: Chemical Metals Industries	**Jim Carroll,** Program Administrator, Land Restoration Program, Maryland Department of the Environment, Baltimore, MD
10:45am	EPA OSWER Application of TCE Toxicity Data in Risk Assessment	**Jayne Michaud**, Environmental Health Scientist, EPA OSWER, Washington DC
11:05am	**Case Study**: Vapor Intrusion Risk Management – Bally Ground Water Superfund Site	**Mitch Cron**, Remedial Project Manager, EPA Region 3, Philadelphia, PA
11:25am	**Q&A and Discussion on Risk Assessment**	
11:45pm	**Lunch (on your own)**	
Engineering & Site Development Session, Michael Gill - Moderator		
1:00pm	The ASTM Standard and Legal Issues Associated with the Development of Property with Potential Vapor Intrusion	**Larry Schnapf**, Attorney, Schulte, Roth & Zabel, New York, NY
1:20pm	**Case Study:** Vapor Intrusion Mitigation Measures at the Former Bethlehem Steel Plant	**Dr. William K. Ahlert**, Vice President, HDR Engineering, Inc., Allentown, PA
1:40pm	Mitigation and Control of Vapor Intrusion	**Ron Mosley**, Environmental Scientist, EPA ORD, Research Triangle Park, NC
2:00pm	New Developments in Vapor Intrusion Control	**David Folkes**, P.E., President, EnviroGroup Limited, Centennial, CO
2:20pm	**Case Study**: The Mott Haven Campus in the Bronx: Long-Term Site Management	**Al Rodriguez,** Counsel to the Bronx Borough President, Bronx, NY
2:40pm	**Q&A And Discussion on Engineering and Site Development**	
3:00pm	**Closing Remarks (Henry Schuver; John Boyer; Lenny Siegel)**	
3:30pm	**Adjourn**	

APPENDIX III: LIST OF POSTERS

Poster Presentations	
Mitigation of Vapor Concerns at the Fulton Fish Market at Hunts Point **	William K. Ahlert, Ph.D., HDR Engineering, Inc.
Analysis of Vapor Intrusion Samples Under the NJDEP's New Low Level TO-15 Method **	Chris Anderson, TestAmerica Laboratories.
Design and Implementation of a Vapor Barrier: Mott Haven School Campus, Bronx, NY	Jeff Belote, CETCO Liquid Boot Company
Cupolex® - The Latest Innovation for Vapor Intrusion & Pre-emptive Mitigation	William J. Cannizzaro, Pontarolo Engineering Inc.
Influence of Sampling Parameters and Meteorological Variables on Measured Soil Gas Concentrations **	James Elliot, Tetra Tech, Inc.
Case Study: Vapor mitigation and groundwater remediation systems of a gasoline-contaminated site in DC **	Andrew Fan, P.E., EPA Region III
EPA Environmental Technology Verification (ETV) Program	Douglas W. Grosse, U.S. EPA, Office of Research and Development
Assessment of Vapor Intrusion at Chlorinated Sites – Case Studies in New York State **	James Hayward, P.E. EA Engineering, P.C.
A Review: Residential Indoor Air Background Concentrations **	Travis Kline, TechLaw, Inc.
Green Buildings: A Sustainable Solution for Vapor Intrusion	Loren Lund, Ph.D., CH2M HILL
EPA Region 6 RCRA Soil Vapor Intrusion Study **	Gary W. Miller, P.E., U.S. EPA Region 6
Vapor Intrusion – The Hidden Hazard in Your Basement: National and International Perspectives and Case Studies **	Joseph Ofungwu, Ph.D. The Louis Berger Group, Inc.
An Evaluation of Indoor Air Sampling Procedures: Short Duration vs. Long Duration Sampling **	Harry O`Neill, Beacon Environmental Services, Inc.
Macro- and Micro-Purge Soil Sampling Methods for the Collection of Contaminated Vapors	Brian Schumacher, Ph.D. USEPA; ORD; NERL; ESD-LV
A Base-Wide Vapor Intrusion Evaluation at Marine Corps Base Camp Lejeune: Utilizing the Tri-Services Phased Approach to Prioritize Building Investigation **	Jennifer Simms, CH2M HILL
Theoretical Risk-Based Groundwater Concentrations for Potential Vapor Intrusion Scenarios at a Chlorinated Solvent Site	Lisa Smith, Ph.D., P.E., Geosyntec Consultants
Predicting Vapor Intrusion Risks in the Presence of Soil Heterogeneities and Anthropogenic Preferential Pathways **	Eric Suuberg, Sc.D., P.E., Brown University
Public Health Evaluation of Vapor Intrusion Exposures: Examples of Key Issues and Cases from the Mid-Atlantic Region **	Lora Siegmann Werner, ATSDR Region 3
Spatial and Temporal Variability in Vapor Intrusion Investigations **	James E. Whetzel. Jr., W. L. Gore & Associates, Inc.
To Purge or Not to Purge? VOC Concentration Changes During Line Volume Purging	John H. Zimmerman, USEPA ORD/NERL/ESD-LV/CMB

** *Posters indicated by asterisks are available at: http://www.epa.gov/osp/hstl/viforum09.htm*

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APPENDIX V: FORUM EVALUATIONS SUMMARY

As of the date of completion of this proceedings document, fifteen Forum participants had completed and returned the evaluation form requesting feedback on the Forum. Most respondents rated all sessions highly (4-5 out of a 5), while some (3-4 respondents) rating the sessions less favorably, scoring most sessions between 3 and 4 out of a possible 5.

Comments and suggestions included:

- Allowing more time to session speakers, as well as more time for questions/discussion after each talk, as well as at the end of each session
- Adding more speakers on the topic of sampling and assessment.
- Feedback from different perspectives (e.g., states, community) was especially useful
- An electronic/online evaluation form (e.g., SurveyMonkey) is more user-friendly and might have elicited more responses
- Coordination in advance among the presenters may help avoid repetition of information already discussed
- Smaller breakout sessions where participants can share ideas more informally should be considered for any future conferences
- Participation on a more national level (not just from the Eastern EPA Regions and states) would have made this truly a "national" forum

Several respondents also commented favorably on specific presentations and speakers; a common theme was the appreciation of including the community/stakeholder perspective.